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THE STONE QUARRIES OF BLOOMINGTON AND BEDFORD, INDIANA.*

MANY members of this society, together with friends and ladies, were fortunate in being the guests of the quarry owners in the vicinity of Bloomington, Ind., and Bedford, Ind., on the 16th of October, 1896, when an inspection was made of the magnificent stone quarries on the 16th and of the Louisville Cement Works, the "Big 4" bridge across the Ohio River and the Louisville Water Works on the 17th. The publication committee took advantage of the several occasions to make some notes of what was seen, with a view to making a record, as set forth in what follows, of the inspections made and the attendant circumstances. In this connection the committee desires to acknowledge its indebtedness to Mr. B. E. Grant, member of the Western Society of Engineers, for the illustrations presented, which are reproduced from photographic negatives made by him.

The celebrated oolitic stone of the Indiana quarries is an element of the St. Louis group showing itself in a massive, evenly bedded stratum of homogeneous limestone, of a whitish gray color, whose grain, viewed casually, has the appearance of a rather coarse sand loosely cemented together. Upon careful examination with the glass, however, this grain proves to be infinitesimal shells and shell fragments all bound together by a firm and even setting of lime carbonate. No art of man could construct a mass at once so firm, even and workable, and at the same time so elastic and strong. The stone comes from the quarry soft, tough and easily cut. In a short time it hardens so that it rings with a musical note (like that from a steel bar) when struck with a hammer. A bar of four feet in length and two inches square may be bent so as to deflect greatly, and when released will spring back to a right line with the promptness and energy of highly tempered steel. Upon being broken the stone parts with a smooth, direct fracture, showing a surprising evenness and continuity of texture, with no trace of laminations, seams or changes of structure.

Geologically, the oolitic limestone is very interesting, and its existence is by no means a problem easy of solution. The more it is studied, however, the more it appears to be the result of calcareous sediment deposited at the bottom of a deep trough in an otherwise shallow sea. The shells of which the greater portion of the rock is composed are, as a rule, much smaller than the smallest ordinary pin head; indeed, barely distinguishable under the most favorable circumstances by the unaided eye. These minute shells are cemented together with a cement composed of fine fragment dust of other shells and an intermediate setting of pure lime carbonate, which renders the whole mass perfectly homogeneous, elastic and resonant.

The stone is found in southern Indiana on the line of the Monon (L., N. A. & C. RR.) through a distance of nearly sixty miles, say from Salem northwesterly to the west branch of the White River, where the Monon crosses the Indianapolis & Vincennes RR. Salem is about thirty miles northwest of Louisville, Ky.

The utility of the stone for engineering structures has been proved by the crucial test of experience, which has extended over a period of about seventy-five years as far as its use in structures is concerned. Its extensive use at places remote from the quarries indicates its general superiority to other stones, durability and cheapness being prime elements involved.

Detached blocks are found at the vicinity of the quarries which apparently have stood the test of ages without deterioration.

The texture is variable, and in good merchantable stone varies in apparance from a very fine to a very coarse sand, and the texture may vary between these limits without materially affecting durability or strength. In color there is the distinctively buff and blue, both of light shade. No explanation has yet been made of the reason for the two colors. They are often seen in one and the same block, the line of demarkation between them being radically well defined, the color changing while the quality of the stone remains the same. Among the quarrymen color is regarded as affecting the appearance of the stone only, though some authorities regard the blue stone as being generally the harder and more resisting. In the quarries the blue underlies the buff, but there is no uniformity in the thickness of either. In some quarries the blue is absent, or nearly so, while in other quarries near at hand it is nearly all blue.

The thickness of the stone deposit, which in some places is as much as sixty feet, is variable, due in part at least to erosion of its upper part. It is covered with

PLATE I.—STAR QUARRY, NEAR BLOOMINGTON, IND.

PLATE II.—HOOSIER QUARRY, NEAR BEDFORD, IND., SHOWING DIRT SEAMS.

* Abridged from the October Journal of the Western Society of Engineers.

a layer of earth of variable thickness, but generally but little at the quarry sites.

The resistance of the stone, as far as the elements and strength are concerned, and also the chemical constitution, are stated clearly elsewhere.

The stone can be shaped with great facility; it can be planed into any shape involving simply straight lines, or turned in a lathe into shapes having circular cross section. It seems about as susceptible to the action of a tool as is wood.

Nature has not made all stone perfect, nor has it made all oolitic or Bedford stone perfect. While enormously extensive parts of the deposit may be of sterling quality, there are still other parts that are quite imperfect. There are a number of characteristic defects. The dirt seams shown in Plate II concern the quarryman more than the engineer, for, while the adjacent stone may be good enough, they involve bad shaped blocks and much waste. The quarryman may also find localities where the stone refuses to break evenly, thus defeating desirable shapes and involving difficult working. At other localities the stone may not have its component shells sufficiently cemented, or the stone may be too coarse, with frequent shells. There are also pebbles, silica sacks, crowfeet and glass seams, and unsightly variation of color. The influence of these defects depends largely upon the purpose for which the stone is to be used. While some of them do not affect durability, they may affect strength, or perhaps affect appearance only. The engineer may, however, so draw his specifications as to essentially avoid all these defects and be assured that there need be no difficulty in obtaining all the stone he may desire. Among other things he would do well to visit the quarry from which he will take his stone.

If appearance is to be a factor in a finished structure, the use of hydraulic cement should be avoided, because it has the effect of badly discoloring the stone adjacent to the joints. There are special cements made, too expensive or not suitable for general work, with which stones may be cemented together. Sometimes, when finished stones are marred by a dog hole, or otherwise, a crafty quarryman will plug the hole with a small piece of stone, using this special cement for the purpose. It might be well to specify against plugged stones.

The time of quarrying is important, since the stone in places is impregnated with what is termed quarry sap, and such stone, if not duly seasoned before being subjected to low temperatures, will crack on being frozen. The period required for seasoning is variable, but generally several weeks. A stone taken from a part of the quarry long exposed requires less time, but taken from newly exposed parts requires more time. Once properly seasoned, however, the action of frost is not to be feared.

The effect of seasoning is to improve the resistance of the stone as to strength, and harden it, though not to an extent that materially affects the facility with which a stone may be shaped.

The wide expanse in which the stone occurs gives unbounded opportunity for opening quarries, and the nature of the deposits is sufficiently variable to render problematic the merit of a quarry until it is well developed. On this account the engineer should take some trouble to become acquainted with the quarry from which he receives stone. In fact, he should visit it with a view to learning the probability that may exist as to whether he will at all times receive suitable stone.

In the report of the Board of Capitol Commissioners of the State of Georgia on the question of using this stone for the State capitol it was shown that one contractor's estimate set down the cost of the Indiana limestone at 60 cents per cubic foot, as against $2 per foot for marble. The report further says:

Salem stone was selected by the commission in the belief that, when strength, beauty, durability and cost are considered, it was the best material offered by the board, and we have been strengthened in that conviction in every way since the selection was made.

It possesses the most remarkable uniformity of grain and texture, is exceedingly bright and handsome in color, can readily be worked in any shape, is peculiarly suited to the design we are carrying out, is less liable to discolor than almost any other stone of so light a color, and the evidence from witnesses qualified to testify is that its durability is equal to that of any stone in the world.

For the purpose of becoming familiar with the constituency and physical properties of this stone, the commissioners have had it subjected to chemical analysis and some mechanical tests, the results of which are herewith reported.

The chemical analysis of Salem stone is:

	Per Cent.
Carbonate of lime	96·04
Carbonate of magnesia	0·72
Oxides of iron and alumina	1·06
Insoluble silicates	1·13
Chlorides of soda and potash	0·15
Water expelled at 212° F.	0·10
Combined water, etc.	0·80
	100·00

This analysis was made in the office of the Georgia State chemist, and agrees with all the published analyses within very close limits.

As to its capacity to resist heat, we had a small block of this stone heated in the office of the State chemist in a cupel furnace to a temperature of 1,200 deg. F. without injury to the stone.

We have also a sample which has been frozen for four hours and shows no sign of injury whatever.

Mr. Champayne, the superintendent of the capitol, and a bonded and sworn agent of the State, has made careful tests of its absorption of water on a random specimen, and finds it to absorb water in the ratio 1 to 42 or $2\frac{35}{100}$ per cent.

Col. L. H. Charbonnier, professor of physics in the University of Georgia, certifies to the board that he has tested the stone for strength in a Riehle testing machine, and finds a resistance of 8,975 pounds per square inch. This strength is less than that shown by Gen. Q. A. Gillmore, and by the Indiana geological reports, which state it at 11,750 and 10,000 to 12,000 respectively, and the difference is due to the fact that the sample tested for the board was a freshly cut specimen, and had not become indurated by exposure, as was the case in the samples tested by the authorities noted. The greatest weight upon any stone in the capitol building is estimated to be less than 90 pounds per square inch.

Referring to the illustrations, Plate I is a view taken at the west end of the Star quarry, near Bloomington, Indiana, where the pit is about 40 feet deep. Two large slabs of stone appear in the center of the field of view. The workmen are breaking up the near slab by the use of plugs and feathers. The farther slab is being drilled for the reception of plugs and feathers. Both slabs have been rolled over 90 degrees from their natural positions to facilitate working. The manner of removing the stones is the same at all quarries.

Slabs of greater or less dimensions are cut from place by vertical cuts made by channeling machines. A series of holes are drilled horizontally on the bed in which wedges are afterward inserted. Driving the wedges splits the slab from its bed. It is then rolled over 90 degrees by use of levers and lines operated by the derrick power, or by other expedients. The slabs are then reduced to sizes that can be handled by the derricks or that are suitable for finished stones of particular sizes.

The Hoosier quarry in the Bedford district is another extensively worked and famous quarry. Plate III is a view of the mill at this quarry, being a substantial stone building. It has an equipment of saws, planers and headers as at other mills illustrated. The view shows the traveling crane and characteristic blocks of stone. The mill at this quarry is said to be the largest of the Bedford district. Plate II is a view at these quarries. At the bottom of the quarry is shown a slab of stone eleven feet high which has just been rolled from its natural place. It has been broken in three places in falling over and the breaks are in the line of nearly vertical dirt seams shown in the view near the ladder to the left. It is easy to see how they are a source of waste.

The day's inspection was finished by visiting the Indiana and Dark Hollow quarries, both extensive and well known, the character of which is well illustrated by the views already presented.

PLATE III.—HOOSIER QUARRY, NEAR BEDFORD, IND.—THE MILL.

ORIGIN OF THE VERTEBRATES.

By STUART JENKINS.

IT is with extreme reluctance that the writer takes up this subject at this time, inasmuch as it is impossible within the narrow limits afforded to handle finally or even effectively. And yet so much of the detail work has already been done by innumerable writers in the wide field of scientific research that it seems likely the mere statement of a working hypothesis will gather up the now scattered strands of confirmation and spin them into a conclusive whole. I shall therefore content myself with treating the matter broadly, advancing only some of the more striking points which seem to give color of probability to the explanation which I propose to offer of the origin and development of the vertebrate organism.

It is beyond question that there is a large number of thinking men who sympathize with Lord Salisbury's now celebrated utterance at the Oxford meeting of the British Association, and no matter what scientific bigots may say to the contrary—for science unfortunately has its bigots as well as superstitions—the feeling is gaining ground that Darwin has not said the last word in regard to evolution, while some few of acknowledged standing refuse adherence to his views altogether. The one element in Darwinism which has enabled it to hold the field so long is the doctrine of descent, the very obvious truth of which appeals to every investigator; but nothing is more astonishing than the amount of perverted ingenuity which has been exercised in order to make the theory of natural selection fit and explain any and every modification of structure. In sober truth it may fairly be said that Darwinism instead of eliminating the agency of miracles from our modern cosmogony has conferred on circumstance the prescience and power of a dozen deities; and when natural selection fails, illimitable time is called in to the aid of the evolutionist, and adverse criticism is silenced by the weight of eternity. It was this question of time which first started the writer on an independent line of investigation, and with years conviction has become strengthened that all such estimates as those of Lyell and Croll are exaggerated and untenable.

The evolution of species, according to Darwin, was brought about by the operation of three forces: Atavism or heredity, spontaneous variation, and (acting on these) the conditions of existence. Of these, the last is understood, or supposed to be understood, but of the causes which gave rise to the other two we are absolutely ignorant, although their existence and influence are beyond question. Another obscure point, and one that has been made the most of by the opponents of evolution, is the fact that crosses between hybrids are in ninety-nine cases out of a hundred absolutely without result. Speaking of this twenty years ago, Huxley said: "This is a very extraordinary circumstance; one does not see why it should be." Those words stand for the fact to-day. Of the gaps which occur in the chain of descent the most obvious and at the same time the most perplexing is that which separates the vertebrates from the lower forms of life. An attempt has been made to fill this gap with the Acidians, the larvæ of which exhibit an axial structure bearing a certain resemblance to a vertebrate notochord; but the analogy has been hotly disputed, and is certainly not definitely established.

Now there is only one theory which seems to adequately explain these hitherto obscure points, and it is this: That the vertebrate organism, instead of being a single organism that has been evolved from a simple to

its present highly complex form by a gradual and cumulative differentiation, is in fact a compound made up of two distinct organisms constantly associated. In other words, that the divergence of the vertebrates from the lower type was caused by the parasitic implantation of one organism of the ganglionic type upon another, the implanted organism giving rise to the cerebro-spinal nerve system and internal skeleton. More than this, the ganglionic type is itself a compound, the ganglions being parasitic on a simple cellular matrix.

Parasitism is a very curious and widespread fact, which is not by any means thoroughly investigated or understood. In its various developments it gives rise to some of the most extraordinary phenomena in the organic world. Indeed, in view of the already ascertained facts, it is impossible to determine the modifications to which it might lead. We have everything from the association of simple "messmates" to the ichneumon fly, which devours organ after organ of the caterpillar which serves the latter as a nurse and is at last eaten up by it entirely. But there are many cases of constant association, where the two organisms react on each other so as to produce modifications in development, but where the parasite stops short of the absolute destruction of its matrix. Some cases of association are so constant and complete that it is only recently they have been detected at all. A well known instance is the lichen. Perhaps some of the most extraordinary modifications are exhibited by the Sacculina, to which I will refer again. One point is clearly established—that a tolerably complex organization is no bar to an animal's becoming permanently parasitic; but where this occurs the larvæ in a large majority of cases enjoy a short period of free movement before they become fixed in their matrices.

There is very strong evidence as to the identity of the organisms which go to make up the compound called the vertebrate, but I will defer consideration thereof to a future article, contenting myself with indicating here the way in which the theory of parasitism seems to throw light upon the dark places of evolution. Taking first the question of infertility between species, let us assume that in the process of vertebrate reproduction* the cerebro-spinal nerve animal supplies the male element and the ganglionic matrix the female element; the conditions necessary for such reproduction must conform to the laws which are known to govern parasitic growth.

There is no question that the product of nutrition varies in different animals. This seems to be indicated by the difference in the size and character of the blood corpuscles, but even more clearly by the fact that the blood of an eel, injected into the veins of a dog, is as instantly fatal as the bite of a rattlesnake. Now it is clear that, if the nutrition furnished by the cells of the matrix is not sufficiently elaborated, or is too highly so, the cerebro-spinal germ will fall on uncongenial ground, and either fail to attach itself or die for want of its appropriate food. Even when, as in the case of the mule, the first cross is productive, the cerebro-spinal parasite is so far aborted that it never develops the reproductive function, and the male mule is deficient. This is not only a simple, but an adequate explanation. In the gradual evolution of the complicated nutritive system of the vertebrates, the whole cell structure of the animal has participated step by step, reacting in its turn on the nerve animal, which, having become accustomed to an extremely artificial food, and having developed an equally extreme and artificial sensibility, would languish under the slightest variation (as we unfortunately know it does), and in the embryonic state die outright. We find that the very same thing happens in the case of recognized parasites, the germs of which never develop unless they reach their proper matrix, which can only be accounted for on the supposition that different animals furnish different qualities of food, and that the assimilative apparatus of the parasite is so delicately adjusted that it cannot become omnivorous. We see from this that the establishment of a species is determined by two things:

The occurrence of a state of equilibrium between the contending forces of the parasite and its matrix, caused by a permanent modification of the former; by a sufficient divergence of the system of nutrition to prevent recrossing with the original stock—and by this I do not mean a modification of the digestive organs, but of their product, a subtile chemical difference, or perhaps it would be better to call it a dynamic difference, which, like isomerism, defies analysis. The existence of opposing forces in the vertebrate organism was clearly pointed out by Huxley. Referring to heredity, he said:

"This atavism which I shall speak of is, as I said before, one of the most marked and striking tendencies of organic beings; but side by side with this hereditary tendency, there is an equally distinct and remarkable tendency to variation. The tendency to reproduce the original stock has, as it were, its limits, and side by side with it there is a tendency to vary in certain directions, as if there were two opposing powers working upon the organic being, one tending to take it in a straight line and the other tending to make it diverge from that straight line, first to one side and then to the other."

What clearer explanation of this fact could be found than in the assumption that the organism is a compound made up of two distinct and to a certain extent antagonistic individuals, the one encroaching, the other resisting, giving rise to perpetual oscillation, with here and there points of equilibrium, which, however, are always more or less unstable, and likely at any time to break out into variations? We get, too, a simple explanation of the "unity of plan" and "evidence of design" which have figured so largely in the polemics of evolution. For, whatever the nature of the matrix—and I am not prepared to assert that it was in every case the same—* we have the same parasite as the moulding and dominant factor, declaring in any and every combination its undoubted affinity.

Reproduction is probably the most inscrutable problem in the organic world. Our wonder at its complexity is only equaled by the stubbornness with which it has resisted all efforts to bring it within reasonable range of the comprehension. It is all very well to point to the fission of an amœbic cell and declare, as some evolutionists do, that in it we have both the basis and explanation of the whole operation, the highest and most complex having been "evolved" from the lowest and most simple. This may be a statement of fact, but previous attempts at demonstration have not succeeded in placing it beyond the reach of controversy. We may believe with the embryologist that the growth of the germ in utero shadows forth the development of the organism in time, and by analysis we may arrive at the operationof three forces, viz., spontaneous variations, heredity and natural selection; but inasmuch as two of these forces are unknown quantities, we are no nearer to a knowledge of the cause which first started living matter on its path of development.

The further back we go in the record, the less satisfactory does natural selection become as a motive power in the evolution of the organism. When living beings were composed wholly of protoplasmic cells, either single or aggregated, absorbing nourishment from the medium in which they lived, and existing under conditions the least liable to fluctuate, i. e., in the sea, the variety of influences grouped under the head of natural selection were inoperative. The conditions under which life was maintained were the very conditions under which it was called into existence, and were therefore the most favorable possible; enemies to prey upon and exterminate there were none, because the source of nutrition was the same in all cases. Whence then came the influence that raised the first organisms above the dead level of their companions? The answer to this is, of course, that it was due to spontaneous variation, which,as Huxley has pointed out, amounts to the same thing as saying we don't know. Then again the force which we call spontaneous variation is a purely empirical deduction based on observation of the higher organisms, in which its existence is beyond question. But are we justified in believing that it holds good in the case of the primitive cell or cell aggregation? Investigation so far has not proved that we are. It may be claimed that embryology indicates it, but the phenomena of embryonic growth are susceptible of an entirely different explanation.

When we turn to the lowest known form of life in search of enlightenment, we are met at once with a difficulty. Modern research has discovered in the depths of the sea a form of life which is the simplest conceivable, nothing, in fact, but an animated jelly. The existence of this protoplasm may be accounted for in two ways: Either living matter is still being evolved from inorganic materials or else this particular form of it has remained unchanged since the dawn of life. If we accept the first assumption, which is purely hypothetical, we must admit that the same conditions which called life into being are still in existence, and consequently there has been no such profound change of environment in the case of pelagic forms of life as would be necessary to produce the profound modifications which they exhibit. If we accept the second assumption, it follows as a matter of course, either that the change of environment has not been sufficient to affect the most primitive forms of life, or else that these forms are so stable as to resist external influences. In the one case we eliminate the operation of external forces, in the other the existence of spontaneous variation. Now geology proves that the conditions of life in the sea have changed, and it is admitted that natural selection cannot act without the aid of spontaneous variation, so that the conclusion is forced upon us that, in the case of pelagic forms, neither natural selection nor spontaneous variation had anything to do with the first changes in living matter.

The one power of varying which can with certainty be demonstrated as belonging to the protoplasmic cell is a certain adaptability which enables it to draw its nutrition from varying sources of supply. This adaptability is governed entirely by the quantity and nature of the foreign matter absorbed along with the constituents of protoplasm. If this foreign matter is of an innocuous character and such as can be cast off again without difficulty, the organism will assimilate and excrete it without injury; if, on the other hand, it is of a kind to set going chemical reactions inimical to the organism, the latter will die. The foreign matter may be converted into a new form before it is excreted, it may even come to be a help to the organism in extracting from the source of its nutrition the constituents of protoplasm, through the chemical reactions which it sets up, but in no case can it be regarded as essential to the maintenance of the most primitive form of living matter, which, like the embryo, lives directly on the elements of which it is composed. Nutrition in the simple cell is really a place of chemical affinity. Its distinguishing characteristics are the limitations imposed upon it, the intangible fineness of the shades of difference which mark the products of the operation, and the complicated nature of the secondary reactions. Besides these there is a well marked preference for any unvarying source of supply, and a certain resistance to a change of diet, if such a word can be used in such a connection. This resistance will in all cases tend to maintain the stability of the organism, and can only be overcome by a compulsory transference, accidental or otherwise, into a new environment. If the transition is too abrupt, the organism will die; if not, it will gradually adapt itself to a new chain of chemical processes; but in no case will the change be other than chemical. The protoplasmic cell remains the protoplasmic cell, the variation consists in an impalpable difference in the quality of the protoplasm. The almost infinite refinement of which this living matter seems capable constitutes the real mystery of vital action, and perhaps not the least curious part of it is that to produce this refinement the matter requires to be elaborated and re-elaborated by vital force.

Now if we consider the matter carefully, there are only three, or at most four, accidents which could compel the first organisms to adopt a new method of nutrition: 1. They might be hoisted out of the sea by an upheaval of the bottom. 2. They might be forced to adopt a parasitic life. 3. They might be silted over with a layer of mud. 4. The chemical constitution of the sea water might become altered. In the first case, if the organisms were lifted high and dry, they would evaporate and die; but if they fell on a low, moist bottom, they would probably live and draw their nourishment from the only available source of supply, the moist earth on which they lay. The change would not be very abrupt, because the earth would be saturated with sea water; but by and by the water would become impregnated with the soluble constituents of the soil, which would be drawn in by the organism and give rise to new chemical reactions. That these reactions were not fatal to the organisms, the existence of vegetable life proves. The changes of environment, however, led to a much more important modification. As the organism no longer lived in a fluid medium, the excretory substances were no longer dissolved and carried away, but deposited throughout and around the cells, there giving rise to the phenomena of vegetable growth. In the second case the parasitism would involve the absorption of no new foreign substances and would give rise to no new chemical reactions; the parasite would simply steal from its matrix the same quality of protoplasm which it would, under normal conditions, have elaborated for itself, but in re-elaborating this food it would acquire a certain chemical refinement which would differentiate it entirely from the cells of its matrix. The change in this instance would not be nearly as abrupt as in the case of upheaval, and the chance of survival would therefore be very much greater. In the third case, if the organism became buried very deeply, it would probably die. If the layer of mud was thin, it would soon reach the sea again, hoisted up by its own excretion. But in any case the change of nutrition would be very slight, if any, because the soluble matter would be extracted by the sediment while it was settling. The fourth case may be rejected as improbable. There is nothing to show that sea water has undergone any radical change. The alterations have rather been of proportion than of element.

Structural modification is the characteristic of cell aggregation, not of the simple cell. In its most rudimentary form it is purely external, and seems to present two well defined types, the massed or roughly globular, which in the first instance must have been invariably shell coated; and the extended, filamentary or branching, which was naked. In the simple cell aggregation the two types are never united in the same individual. This outward divergence of form is of course due to mechanical causes, but it is not obvious at first sight why it should be. It is easy to understand how an organism would become naked after the power of locomotion had been acquired, because the movement to and fro would leave excreting matters behind, but this does not apply to a stationary organism. The explanation seems to be this: The massed, shell coated organisms lived on the bottom in still water, while the long branching naked organisms lived in running water, probably some ocean current like the Gulf Stream. This running water would carry away all excretory matters, and the drag of it would pull the organism out into its slender form. It would also bear off the germ cells cast loose, and finally deposit them on the bottom, where they would in some cases light in the mouths of the other type, there to commence a parasitic existence, and give rise to the evolution of a nervous system. The evolution of a nervous system is now attributed to a gradual process of differentiation. Luys, in his work on "The Brain and its Functions," states that at first the sensibility was diffused over the whole organism, but that by and by there grew up a division of labor among the cells, and that some became nerve cells, and some muscle cells, and so on, until the whole complex organism was evolved.

If we accept that explanation, it means one of two things: Either the cells deliberately divided the work among themselves, which is, of course, absurd, or else, owing to some inherent property, they were compelled to differentiate along certain definite lines—that is to say, we bestow on the cell a self-creative energy which lifts it at once beyond the influences of second causes into the region of the supernatural. Between such an explanation and that offered by the theory of parasitism, the contrast is too obvious to need more than mention. The implantation of one simple organism of a fixed type upon another affords an explanation at once rational and direct.

With the evolution of a nerve system we touch on the borderland of the reproductive mystery. Cell multiplication, although not entirely bereft of obscurity, is so far obvious that we can form a rational conception of it; but it is far otherwise when we come to deal with the complex elements of the compound organism. No theory of evolution affords the faintest clew to the intricate processes which connect the germinal vesicle with the mature vertebrate; but with the key which is furnished by the theory of parasitism, we may at least make an approach to an understanding. In the first place it explains why, in the compound organism, two elements are always necessary for complete reproduction. Indeed, it seems to me that the very exist-

* I return to this immediately, but there is a curious point I wish to note in passing: It is now held that impregnation consists essentially in the fusion of the male cell and the female cell; that in this act the protoplasm of the two cells as well as their nuclei coalesce, and that the use of the male element is to confer an added vitality on the ovum which is potentially capable of developing by itself into a fresh individual. Further than this the concurrent testimony of almost all observers tends to show that only one spermatozoon is required for the purpose. On the other hand the observations of Fol and Hertwig indicate that where more than one spermatozoon enter the ovum, and there are consequently several male pronuclei, the segmentation is irregular and the resulting larva a monstrosity. Even Selenka, whose results differ somewhat from this, concludes that normal development cannot occur when more than one male pronucleus fuses with the female pronucleus, and holds that where he has observed such normal development after the entrance of more than one spermatozoon, the majority of male pronuclei become absorbed. We have here a contradiction. If the male element fuses with the female element, losing thereby its identity and adding only an increment of vitality to the compound, the entrance of two or more spermatozoa could only result in a larger and more vigorous germ. It is inconceivable that the result should be a monstrosity. The fact that it is so would seem to indicate that the fusion is not as complete as supposed, and the assumption in the text at once affords a rational explanation of the growth of monstrosities, since, if the male element is in reality the nerve germ, a multiple impregnation, where the spermatozoa survived, could only result in the overcrowding of the matrix and an unnatural demand on its powers of nutrition, leading inevitably to the production of a compound of aborted organisms instead of the normal individual.

* There is a wide field for speculation here. If we assume a number of implantations in a variety of matrices, we get a very simple explanation of the origin of genera, and one which seems to meet the case fully. There is no good ground for believing that the implantation occurred in one individual only. The geological record shows that the nerve parasite enlisted as an independent organism in countless numbers during the period immediately preceding the appearance of the vertebrates; consequently, the opportunities for such an implantation were correspondingly numerous. It must be borne in mind that the divergence in the products of nutrition at this early period must have been very slight, and it is conceivable that there might be a large variety of forms in which the nutrition was almost, if not quite, identical. When once the implantation had occurred, however, the internal secretion of waste products by the embedded parasite would give rise to a series of chemical reactions in the tissue of the matrix, which would tend toward a rapid divergence and the ultimate establishment of species. It seems probable that there will have to be a considerable readjustment of our present classifications, since affinities, now unrecognized, will assuredly crop up, while some of those at present claimed will prove to be erroneous.

ence of duality of sex is a clear indication of the compound nature of the organisms in which it is exhibited; it is the latest expression of a primitive fact and its logical sequence. Where the nerve parasite was imperfectly developed, and consequently made but small demands upon its matrix, reproduction could be carried on in one compound individual without so far impairing nutrition as to cause the death of its elements; but a point would ultimately be reached when the nutrition of the nerve animal would so exhaust its matrix that the double function would become impossible, and in the constant struggle between the two, one or other would monopolize the available nutrition in the effort to reproduce its own half, and so, as the beam swung, the male or female element would predominate.* When once the differentiation of sex had been accomplished, the only effect which nerve development could have on the reproductive function would be in the direction of reducing fecundity. It is hardly necessary, perhaps, as a proof of this, to point out the difference between fishes and human beings.

When the highly complex compound which led to the vertebrate organism was formed, the reproductive function was at first in a very uncertain and disturbed condition; that, I think, is the logical conclusion to be drawn from the curious and wasteful method in force among fishes, and I do not see how else we are to account for it. It is incredible that, after millions of years of auto-development and the perfecting influence of natural selection, the first members of the highest type of animal should suddenly cast all heredity to the winds, and break out into the most loose and happy-go-lucky kind of generation that it is possible to conceive. The thing is not reasonable on the face of it, but when once we have grasped the idea of the compound nature of the vertebrate organism, the fact ceases to be an enigma. In the first place the parasite would not affect the reproduction of its matrix, but as it became accustomed to its environment and gradually developed, it would begin to assert its individuality and get to breeding on its own account. This might lead to impregnation of the ova before they were extruded, but I am inclined to doubt it. It is much more likely that both the milt and the ova were cast into the sea at the same time. Then, according to the law which governs all parasitic reproduction, the nerve germs would recognize and attach themselves to their appropriate source of nutrition, i. e., the ova, and the reproduction of the compound organism would be accomplished by the very method which still obtains among most fishes. Afterward, owing to the causes already cited, would come the differentiation of sex, but a change of method would only result from a progress in development.

This brings us to another perplexing point in the chain of development, and that is the obscure affinities of some of the earlier types. In reference to this Huxley says:

"From the point of view of the evolution hypothesis it is necessary to suppose that the reptilia have all sprung from a common stock, and I see no justification for supposing that the rapidity of their divergence from this stock was greater before the epoch of the Trias than it has been since. Consequently, seeing that the approximation of the oldest known representatives of the different orders is so slight, reptiles must have lived before the Trias for a length of time compared with which that which has elapsed from the Triassic epoch until now is small—in other words the commencement of the existence of reptiles must be sought in remote Paleozoic times."

Oscar Schmidt, commenting on this, adds:

"Comparison thus points us back to ages which afford no record of the actual derivation of this class (Reptilia). Even the Ichthyosauria and Plesiosauria, so frequently mentioned in conjunction, deviate widely from one another in very essential characters, which refer their supposed origin to a remote period. We are thus thrown back on such forms as may have been analogous to the Labyrinthodont; nay, the question arises whether the Ichthyosauria alone, or perhaps the Plesiosauria with them, did not diverge from the fishes independently."

Assuming the compound nature of the vertebrate organism, the obvious explanation of the difficulty is this: That as a result of the parasitic implantation the first individuals would exhibit in themselves a progressive development, and would in the course of their life give birth to a series of progressive types corresponding to the stage of development in the parent or parents. There are no very definite limits to the growth of fishes even now—although this applies wholly to size and not to structure; and the duration of their life is as little fixed. Even within known limits there would be ample opportunity for many adjustments and readjustments of the relation between the parasite and its matrix, and it seems impossible that the changes should not have influenced the character of the offspring. There would be a certain community of type among the individuals of one birth, but some of them might, and probably would, diverge very widely from the parental type, because these first forms must have exhibited an extreme flexibility. †

A natural corollary of this is that the changes exhibited by the embryo in utero, instead of shadowing forth hair-fine shades of development, spread over millions of years and innumerable individuals, rather indicate progressive developments occurring in a few individuals within a comparatively short space of time. The latter assumption is at least as legitimate as the former, and it has this great advantage—that it so reduces the time required for the evolution of these early types that it comes well within the available limits.

(To be continued.)

* This serves to explain the fact long recognized by breeders that if the male is withheld for a certain number of days after the ovum is ready for impregnation, the offspring will be male, whereas if impregnation takes place immediately, it will be female. In the first case the vitality of the ovum has become so far exhausted that the male element is able to gain the predominance; in the second the ovum having just left the Graafian vesicle is full of vitality, and able therefore, to turn the scale to its own side. Exceptions to this rule would be determined by varying degrees of health and vitality in the parents and consequently of the vital energy of the respective germs.

† It is a well recognized fact that in animals, though less frequently than in plants, peculiarities of structure occur which appear to be absolutely useless to the life of the individual, although they are not rudimentary organs. Natural selection fails utterly to explain their existence, but the theory of parasitism accounts naturally for variations unconnected with immediate utility.

CYCLAMENS.

THE strains and races of Cyclamen, which form so beautiful a display at this season of the year, are all the result of variation under cultivation of one species, C. persicum; so that in this case the "improvement" cannot be attributed to cross fertilization. Lately, there have been fresh departures from the type which bid fair to be the forerunners of different forms, and are thus of great interest to students of evolution, as well as to florists. Whatever we may think of them now from the æsthetic point of view, it is certain that they will develop into forms of greater beauty in the future.

The illustration shows a variation which we first observed a few years ago, in which the petals branch so as to form crests and fringes analogous to what we see in many of the kails.

Variation consists in the branching of the edge of the petals, so as to form a fringe analogous to what we have in the Chinese primrose. This race was first brought under our notice by M. de Langhe-Vervaene, of St. Gilles, Brussels, who designates his strain as "Papilio." Specimens of this Cyclamen persicum var. papilio were recently brought under the notice of the floral committee, and were specially remarkable for the breadth of the petal, which was often less reflexed than usual. No doubt these variations originate in some disturbance of nutrition at a particular stage of growth, but this explanation does not lead us very far in determining the proximate causation. In any case, it is desirable to record the first beginnings of changes which may ultimately prove of great horticultural importance.—The Gardeners' Chronicle.

A FRINGED CYCLAMEN FLOWER, C. PERSICUM "PAPILIO."

PROFESSOR CROOKES ON PSYCHICAL RESEARCH.

IN his presidential address delivered recently to the Society for Psychical Research, Prof. William Crookes, F.R.S., devoted himself to an attempt at clearing away some of the "scientific superstitions" which tended to prevent many possible coadjutors from adventuring themselves on the new and illimitable road which the society was endeavoring to open.

Psychical science was, he said, the embryo of something that might in time dominate the whole world of thought. Human ignorance beset research in this direction with many difficulties, but conscious ignorance was a healthful stimulant if it led to the conviction that one could not possibly lay down beforehand what did not exist in the universe or what was not going on in the world. One of the greatest thorns in the path of the society was the fact that very many people started with certain presuppositions depending upon a too hasty assumption that we knew more about the universe than really was known. For instance, among those who believed with him in the survival of man's individuality after death there was an inveterate and widespread illusion that ethereal bodies, if such there were, must correspond to earthly bodies in shape and size.

The human body, it was true, was the most perfect thinking and acting machine yet evolved on this earth, but its excellence for its varied purposes depended, of course, upon the conditions by which it was surrounded. Its action was, for instance, entirely governed by the strength of the force of gravitation, which had not apparently varied at all during the ages in which animated thinking beings had existed. Were the force of gravitation to be either doubled or decreased, there would be remarkable changes in the type of humanity to suit the altered state of affairs. Yet popular imagination, taking no heed of this, presupposed spiritual beings to be superior to the laws of gravitation, and yet to retain shapes and proportions which gravitation originally determined and only gravitation seemed likely to maintain. His own picture of the constitution of spiritual beings would make them centers of intellect, will, energy, and power, each center retaining individuality, persistence of self and memory, and each mutually penetrable, while at the same time permeating what we called space.

Addressing those who not only took too terrestrial a view, but who even denied the possibility of an unseen world existing at all, Prof. Crookes said he would like to point out to them the difference in the apparent laws of the universe which would follow upon a mere variation of size in the observer of them. Following this idea out, he imagined, first, a homunculus of microscopic size, and, next, a human being of enormous magnitude, showing by familiar illustrations how the supposed laws of matter and of the universe would appear to such beings to be quite different from those now accepted. Was it not possible, he asked, that we also, by the mere virtue of our size and weight, might fall into misinterpretations of phenomena; and that our boasted knowledge might be simply conditioned by accidental environment, and therefore liable to a large and hitherto unsuspected element of subjectivity?

Passing thence to the speculation of Prof. W. Jaines, of Harvard, which dealt with the possible difference in rapidity of sensation on the part of beings presumably on a larger scale than ourselves, Prof. Crookes applied this general conception of the impossibility of predicting what unseen forces might be at work around us, specially to telepathy, or thought transference—i. e., the transmission of thought and images directly from one mind to another without the agency of the recognized organs of sense.

Was it inconceivable, he said (after making an elaborate calculation as to the vibrations which produce sound and light), that intense thought, concentrated by one person upon another with whom he was in close sympathy should induce a telepathic chain along which brain waves should go straight to their goal without loss of energy due to distance? Such a speculation was, he admitted, new and strange to science; it was at present strictly provisional, but he was bold enough to make it, and the time might come when it could be submitted to experimental tests.

In conclusion Prof. Crookes spoke of the work which was being done by the society as likely to form no unworthy preface to a profounder science of man, of nature, and of "worlds not realized" than we yet had; and said he could see no reason why any man of scientific mind should either shut his eyes to or stand deliberately aloof from it.—London Times.

MORALITY IN THE MONKEY.

THERE is nothing better known than the tricks of monkeys. The animal makes us laugh, but it is regarded as commonplace. Yet, if we reflect upon them instead of laughing at them, we may gather from these tricks, which are natural performances, many valuable observations that are easily made, and that will throw an unexpected light upon one of the profoundest subjects of study that science has left up to the present almost unexplored. Much has been written upon the instinct and intelligence of animals, and much amusement especially has been afforded by the anecdotical part of their traits of mind or reason, which are sometimes superior to what might be found in man, were he as small and ignorant as certain insects, for example. But after we shall have conceived and organized the comparative psychology of all animate beings, and shall have deduced data therefrom of an indefinite value to human psychology, we shall discover therein terms of comparison between phenomena whose characters we have always limited ourselves to determining without searching out their relations.

This, however, is the condition of all sciences in course of formation, and, what should be well guarded against, their peril. The analysis is so attractive, so solid, and so remunerative in immediate results that it is impossible for one to tear himself away from it, since it gives facts at once. Only, and this is its inconvenience, it gives them to such a degree that it does not leave enough room for ideas, and when they come we do not know where to put them; we do not even dare to produce them for fear that, to-morrow, perhaps, another analysis may destroy them.

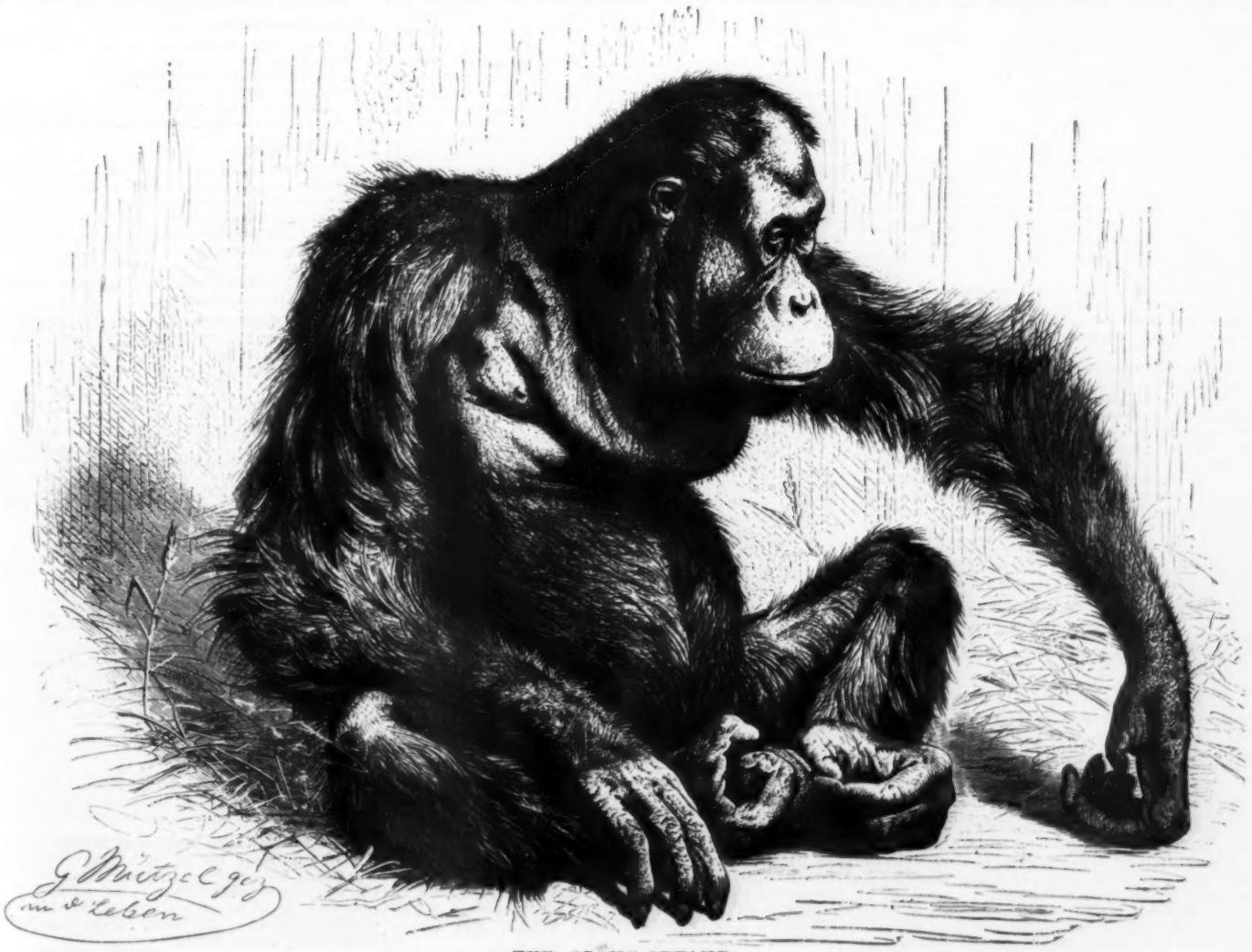
Meanwhile the fact, nevertheless, remains, that in affairs of life and thought, syntheses are alone real. Analysis does not exist in nature, but is merely a tool to work with—the key for want of which no door would ever open upon the unknown. When the door does open, it is for the reason that, before the analysis, there was an idea, which is always a more or less bold, more or less probable synthesis, without which no analysis would ever have had even a pretext.

The two traits that I have to mention are interesting in that they seem to prove the existence of a true animal morality. We know beyond a doubt that in several of our domestic animals, and even in wild animals that have been tamed, there is, in addition to a fear of punishment, a conscience of the misdeed that causes the animal in fault to hide or make its escape, and that it often denounces itself by nothing but its suppliant attitude. But the case of our two monkeys, as we shall see, is otherwise curious and seems to reveal an unlooked for morality. At my grandfather's home in Guadaloupe there was a very large African monkey of remarkable intelligence. He carried imitation so far as sometimes to frighten spectators by his tricks, for one day he took it into his head to snatch a negro baby from the mother's breast, to carry it to a roof, and to shake it in offering it his breast. It was with the utmost trouble that one approached him in order to get the infant away from him.

In addition to his dexterity and strength, he was very kind and affectionate toward the other animals of the house, particularly toward a goat, with which he often played. This goat passed the day in a piece of ground covered with prickly pears, succulent plants bristling with spines grouped in radiating tufts. Every evening when the goat returned from his pasture he was covered with these spines, which were fastened to his entire coat. He was thoroughly beset with them, and the poor animal would not have been able to sleep without being in torment.

He went in search of the monkey, which, now on the ground and now creeping over him from place to place, removed from him, one by one, and with patience and the accuracy of a surgeon, two or three thousand spines without pulling out a hair and without pricking himself a single time. It cannot be denied that he here performed an act of kindheartedness and of true charity, a deliberate act inspired both by feeling and reasoning, and that such act, repeated every day, was one of

THE ANDAMAN APE.



THE ORANG-OUTANG.

morality, if there ever was such a thing. Merely from this view point, the observation would merit the trouble of recording it, but it will assume a very different interest when we state how the monkey crowned this daily trait of general charity for suffering beings and of particular affection for his friend the goat.

Then, when this good Samaritan of the tropics had finished up to the last spine his so touching work, and as if there were in this simian soul two consciences, one of a good monkey and the other of a bad macaeus, or as if Nature had desired to prevent the individual morality of the civilized monkey from atrophying the generic malice of the zoologic quadrumana, our good Samaritan was transfigured in a gambol, and, in order to repay himself for his deeds of charity, became malicious toward the poor goat, pulling his beard, sticking one of his fingers under his eyelids and sometimes under his tail, and plucking out a handful of his hair, but never letting him go without having done him some bad turn. The goat did not try to escape, either because he accepted this annoyance as the price agreed upon for the cure or because he judged the thing equitable, or perhaps because he thought that this last formality was necessary for the success of the operation.

However this may be, if analysis or even hypothesis does not seem capable of solving the question of knowing what the goat thought of it, what the monkey did clearly revealed a very curious and very complicated operation of consciousness, and one which, as far as our memory serves us, has never been observed. The phenomena of double consciousness, so feverishly pursued, hoped for and solicited as being capable of unmasking one of the most dreadful secrets of the soul, is produced therein under conditions of independence, and, I may say, of purity, which gives it a great value.

That the animal has the consciousness of evil, that he comprehends the responsibility of it, and that he even repents of it in his own way by becoming, for example, still more submissive and zealous, has been noticed hundreds of times. There is no doubt of it, and we shall presently recall it. But that, in the generality of certain species or in some privileged individuals, there is a division of consciousness or an antagonism of good and evil that oscillates, as in the human soul, under the action of I know not what law of compensation reigning over all living beings, is a dream that overpowers us when we vanish away in the imaginary spaces of psychology.

Now this is precisely what is suggested to us by this unknown monkey which lived in 1810, and which after eighty-seven years of complete obscurity is, perhaps, if I do not exaggerate his scientific value, going to assume the rank of an anthropopitheco-psychologic document, if I may be allowed to express myself thus.

Although it does not allow of speculations of so high a range, the trait that we are going to produce is none the less a contribution to be gathered as a fact of simian morality, and is thereby connected with the general considerations that we have used as an introduction to this article.

At the Saintes, an island dependent upon Guadaloupe, a small detachment of infantry was quartered in a house in which it messed, and in which there was consequently a supply of provisions distributed all about.

The supply of eggs was placed upon a shelf over a door, so as to put it out of reach of rats and other marauders.

One day, the cook, upon going to get some eggs, came near falling to the floor with the entire stock upon observing that five or six eggs, placed at the top of the basket, consisted of nothing but empty shells. Upon examining them, he saw that the thief, after making a very small hole at the point, had sucked out the contents and had then carefully placed the egg in the same spot whence he had taken it.

There was a negro in the employ of the post, and as negroes are gourmands and do not admit that it is a theft to steal from their master, there was no one else to suspect. So he was accused and threatened with a flogging. He protested his innocence, and swore by the great gods that, if he were spared, he would do his best to discover the guilty person. He was therefore given carte blanche.

In addition to the negro, there was a monkey at the post, and the former, knowing better than the Europeans the malice of his quasi-congener, said to himself at once: "It was that monkey that sucked those eggs."

He therefore set himself to watch, and, after two or three days that the thief had allowed to elapse, doubtless in order that his crime might be forgotten, he saw the monkey climb up the door frame, put his hand up to the shelf and hoist himself up to it and seat himself thereon. Thus master of the place, the animal delicately picked up an egg, made a hole in it with the nail of his forefinger and then sucked out the contents.

Then, with all sorts of precautions, he replaced the egg, when the negro, allowing himself to be seen, closed the door, and seized the thief as he was about to jump to the floor. It is unnecessary to say that the negro, upon dragging him before the justice, transferred to him a modicum of the correction that had menaced an innocent person.

The interest of the story does not reside in the subtilty of the process. The monkey in a wild state does not employ any other in order to feed upon the eggs that he obtains by robbing birds' nests. Experience, if not the instinct of his race, has taught him that if he breaks an egg in order to eat it, only the crushed shell will remain in his hands and that the contents will escape before he can seize them. He has learned that the shell is a natural vessel for want of which the exquisite emulsion would be for his gluttony a vain dream. He knows that this vessel is extremely fragile, and he caresses rather than handles it. But what he does not do in a wild state is to delicately put the egg back in the place whence he took it. In the anarchy of the woods, he has no fear that an animal stronger and more honest than he will be at a distance of a few steps to seize him, or, if he escapes, to find evidences of the crime in the remains of the shells that he has allowed to fall to the foot of the tree.

Now, what this thief does not do in a state of nature he did here through a series of reasonings in which we cannot refuse to recognize an act of conscience, a feeling of responsibility, the fear of punishment and a ruse in order to avoid it.

To have done away with the corpus delicti would have been the safest thing, but if he had thrown the empty shell on the floor, he would not have been able to pick it up except in small fragments, and this would have taken some time. Had he attempted to carry it away, he would not have been able, having one hand occupied, to descend by the door frame. Had he jumped, and fallen upon all fours, he would have crushed the shell.

There, therefore, remained nothing else to do but to put things, in appearance at least, in such a state that the discovery of the theft would be retarded. This was a provisional method and a desperate one, but one that is as natural to animals as to men, and shows them to us taking precautions for retarding, as far as possible, the discovery of the misdeed or crime that they have just committed.—E. Monton, in La Revue Scientifique.

[As a supplement to the above picturesque description of what the somewhat imaginative writer considers examples of animal conscience, we give cuts of two representatives of the simian tribe, both illustrating its higher developments. The conscience of man, we should remark, is not formed by dread of purely temporal punishment; no view of ethics will admit that, in the absence of the punishments of the law, all men would become like Mr. Hyde, of Robert Louis Stevenson's story, void of conscience and criminal. The higher conscience would persist in all conditions, and should be distinguished from the dread of a whipping shown by an intelligent dog or monkey. On the subject of animal intelligence many articles have already been published by us. We would especially refer to our SUPPLEMENT, Nos. 683, 841, 868, 938, 948, 983, 1070, 1078 and 1100.]

MEDICAL TREASURE TROVE IN SWITZERLAND.

OUR knowledge of the medico-military organization of ancient Rome owes not a few of its most distinctive details to Switzerland, says the London Lancet. Windisch, for example, the Vindonissa of antiquity, has proved to the Swiss archæologist a real mine of surgical treasure trove, lying as it does at the junction of the Aare and the Reuss and commanding on the one side the two Italian highways (from the Great St. Bernard and from Como) and on the other the communications with the Rhine and Danube.

Here was found the celebrated monument with inscription to Tiberius Claudius Hymnus, surgeon of the Twenty-first Legion. Here, too, has been unearthed quite an armamentarium chirurgicum in the shape of medicine chests, instrument cases, with pincers, scalpels, needles, catheters, and such like in fine preservation. Dr. Conrad Brunner, of Zürich, has based on these discoveries a highly interesting monograph entitled "Die Spuren der Romischen Aerzte auf dem Boden der Schweiz," and the enthusiasm he has awakened in the medical branch of archæological research bids fair to fructify in even more precious discoveries. Not many days ago there was disinterred at Baden-im-Aargau, not far from Windisch, a Roman house containing fourteen apartments, varying in size, and with walls painted with designs of the highest interest for the classical scholar. When exposed to the light of day there appeared about the structure a number of fibulæ and vases and in the apartments themselves such a quantity of surgical instruments as to favor the conclusion that the house was neither more nor less than a hospital. This is in many respects a novelty in medical archæology. We have very clear notions as to what the valetudinaria or infirmaries for slaves on patrician estates were like; but a building for the wounded or ailing Roman soldier presents points of interest, as hitherto no such buildings have been found in their integrity. Moreover, when we add that never either in Switzerland or in any other scene of Roman military occupation has there been found so large an assortment of surgical instruments as in this newly discovered hospital near Baden, we have said enough to awaken scholarly and professional curiosity in the spot and to lend additional attraction to the picturesque "Kurort," known since the first century A. D. on the banks of the Limmat.

Eluedin, or Benzine Jelly.—Directions for preparing gelatinous emulsion of benzine or other low boiling fractions of petroleum have repeatedly been published in these columns. Attention has again been called to this form of cleansing and grease eradicating preparation by Sztankay (Pharm. Post), who states that the cleansing power of such an emulsion is greater than that of the plain hydrocarbons themselves. A specialty sold in Hungary as "eluedin" or "seifenmilch" proved to be such. For the preparation of the emulsion he recommends the following formula: About 3 grammes of soap is dissolved in 50 to 60 c. c. of lukewarm distilled water in a 2 liter flask. The benzine is gradually added, while thoroughly shaking the contents of the flask. If the emulsion is slow in forming, the flask may be placed in warm water, or 50 to 100 c. c. of warm water (temperature 60° to 80° C.) may be added with renewed shaking. In this manner 1,000 to 1,500 grammes of the hydrocarbon can be emulsified with only 3 grammes of soap. The emulsion is thick and must be set aside for several days, after which time the excess of water separates.—Western Druggist.

Sensitive Litmus Paper.—The strong alkaline cubes occurring in commerce are covered with twelve to fifteen times their quantity of water, and allowed to stand for one day. The deep blue mixture is then treated with sulphuric acid until it becomes a light red, and heated on a steam bath for fifteen minutes. To the liquid, which generally turns blue again, dilute sulphuric acid is added until the filter paper becomes of a reddish-violet on immersion. When cold it is strained through a cloth, and the liquid is so adjusted, by the addition of drops of dilute sulphuric acid or traces of powdered litmus, that pieces of filter paper, if immersed and quickly dried, take the desired red or blue tint. This method readily yields papers of a sensitiveness 1 = 150,000.—Pharm. Zeitung and Chem. Zeitung.

SELECTED FORMULÆ.

Ink for Glass.—A correspondent gives the following formula for an ink for writing on glass:

Bleached shellac	10 parts.
Venice turpentine	5 "
Turpentine	5 "
Lampblack	5 "

Dissolve the shellac and Venice turpentine in the turps in a water bath, then stir in the lampblack. Write with a pen as with ordinary ink.

For the Bath.—

BATH PASTE.

Bicarbonate of soda	3 ounces.
Tartaric acid	2½ "
Powdered starch	4½ "
Oil of almonds	2 "
Otto of rose	2 drops.
Oil of lavender	4 "

Gently dry the soda and acid. Mix the soda with the starch, then add the acid. Mix the oils together, add to the powders, make into a stiff paste, and bottle. A large teaspoonful should be added to each bath.

BATH SOAP PASTE.

Soft soap	8 ounces.
Glycerine	1 "
Alcohol, 94 per cent	4 drachms.
Oil of lavender	4 drops.

Mix the oil, alcohol, and glycerine, and carefully mix with the soap to form a paste.—Bulletin of Pharmacy.

For Wasp and Bee Stings.—

CARBOLIZED GLYCERIN.

Carbolic acid in crystals	1 drachm.
Glycerin	4 "
Distilled water	1 "

Dissolve the acid by the aid of a little heat. Two or three drops of the preparation should be placed on a little cotton wool, which, if possible, should be tied over the wound, so keeping the air away. Care should always be taken to see that the sting is not left in the flesh. That of the bee almost always is, and keeps on injecting its poison.

Other remedies are a solution of ammonia, and bicarbonate of soda made into a paste with water and vinegar.

German Cologne.—

Oil bergamot	1½ oz.
" lavender	½ "
" lemon	2 dr.
" wild ginger	1 "
" santol	1 "
" neroli	15 ms.
Ionone	5 gr.
Fr. musk (1-100)	6 oz.
Fr. storax (1-10)	1 "
Alcohol	80 "

Mix and allow to stand two or three weeks.

Liquid Dentifrice (said to resemble odol).—

Salol	25 gm.
Saccharin	0·04 "
Oil peppermint	5 "
" cloves	1 "
" caraway	0·5 "

Rectified spirit to 1 liter.

Witch Hazel Jelly.—

Powdered tragacanth	160 gr.
Glycerine	5 oz.
Distilled extract of witch hazel	10 "
Otto rose, sufficient quantity.	

Triturate the tragacanth with the glycerine, add the otto, and then the distilled extract of witch hazel.

Label Varnish.—

Sandarac	60 parts.
Mastic	25 "
Camphor	1 "
Lavender oil	8 "
Venice turpentine	4 "
Ether	6 "
Alcohol	44 "

Macerate, shaking frequently till the gums are dissolved.—National Druggist.

Stratena.—The following formula is given in the Standard Formulary as yielding an article similar to Van Stan's Stratena:

Acetic acid	4 fl. oz.
Glue, white	3 av. oz.
French gelatine	240 gr.
Shellac varnish	4 fl dr.
Water, distilled	4 fl. oz.

Dissolve the glue in the acetic acid with heat, and the gelatine in the water with heat. Mix the two solutions gradually and work until a uniform mixture results; then add the shellac varnish. Mix thoroughly and bottle.

Liquid Cement.—

Russian isinglass	100 gm.
Gelatine	20 "
Acetic acid	125 "
Water	125 "
Strong solution shellac	20 "

In the acetic acid dissolve the Russian isinglass. In another vessel dissolve the gelatine in the water, by the aid of heat. Mix the solutions little by little, with constant agitation, and finally add the alcoholic solution of shellac.

A simpler form is the following:

Fish glue	75 gr.
Acetic acid, glacial	5 dr.

Melt together the ingredients and heat until the liquid has become of a sirupy consistence, so as to form a jelly on cooling. This must be heated before using.

Cement to Fix India Rubber on Metals.—Dissolve one part of gum lac in ten of cold liquid ammonia. This will take a month or so to effect. The solution allows the face of the India rubber to be softened, so that it may be applied to metals, wood, etc. When the ammonia evaporates, the India rubber hardens and adheres firmly to the metal.

ENGINEERING NOTES.

Some remarkable performances in the matter of drilling steel have recently been accomplished in the United States with drills in the bodies of which have been inserted tubes conveying oil under pressure to the point. With such a drill a hole ¾ in. in diameter has been drilled through steel to a depth of 12 in. in 15 minutes. The speed of rotation was 1,000 turns per minute, and the oil was supplied at the rate of 2 gallons per minute.

On January 21 a mass of rock estimated to contain 8,000 to 10,000 cubic yards fell from the top of the steep bluff overlooking the Harlem River Speedway, just south of Washington Bridge, New York City. It divided into three parts as it slid, wrecked a derrick, demolished a hoisting engine and swept away about 100 feet of the 6 foot masonry wall, the parts crushing through the finished road so as to make necessary its entire reconstruction.

Dockyards, the want of which is seriously felt in Japan, are projected on a large scale at Hyogo, Moji, Uraga and Hakodate, and the one which is in course of construction at Yokohama is approaching completion. The new harbor at Osaka is to cost close upon $20,000,000, and when finished will possess a military as well as a commercial importance, being specially designed, it is said, with a view to the simultaneous embarkation of large bodies of troops.

A sample of Japanese coal from Tubari, in the island of Yezo, has recently been analyzed by Mr. Frank Browne, and reported in the Chemical News. In lumps it is black, in powder it is chocolate brown; it burns readily, with a bright, smoky flame, that soon subsides, leaving a glowing mass; it is non-caking, and contains, per cent., moisture, 3·83; volatile combustible matter, 36·62; fixed carbon, 42·70; ash, 16·85; the ultimate analysis showing C, 62·84; H, 5·37; N, 1·08; O (calculated), 11·91; S (combustible), 1·18; ash (containing 0·49 per cent. of sulphur), 17·52 per cent. Sp. gr. 1·411; heat of combustion calculated = 6,826 cals.

The progress of railways in Ceylon has been very satisfactory from every point of view. According to Indian Engineering, the traffic carried has risen steadily from 162,295 tons and 1,966,280 passengers in 1887 to 411,915 tons and 4,821,867 passengers in 1895; there has been no abnormal and sudden fluctuation, but one steady increase—a proof that such increase is not due to temporary circumstances. As the mileage has increased from nearly 180 miles to nearly 300 miles in the interval, or about 66 per cent., it is clear that the increase of 154 per cent. in weight of goods, and of 445 per cent. in number of passengers carried, is not all due to increase in mileage.

At a recent meeting of the Western Foundrymen's Association, held at Chicago, the report of the committee on drying cores was read by the secretary, who stated that the committee have determined, from a series of tests made in different ovens, that 350° to 400° Fah. is the best temperature at which to bake cores thoroughly. This temperature applies to all sizes of cores; the only difference between large and small is settled by the length of time they are left in the oven —that is to say, a core 1 in. in diameter, and one 12 in. diameter will bake equally well at the temperature given, only it will take the 12 in. core at least twelve times as long to bake as the 1 in.

An arrangement that is being used with some favor in England, of fast and loose pulleys, consists in cutting a number of grooves obliquely on the surface of the fast pulley, about 3 in. in length, running from that side nearest the loose pulley, and terminating about the middle by a gradual diminution in the depth and width of the cuts. These grooves, which are cut about 1 and 1¼ in. apart and in the direction in which the belt runs, have the effect of taking hold of the belt immediately it leaves the loose pulley, and in worm-like fashion draw it on to the whole surface of the fast pulley, thus relieving the belts at once from the pressure of the guide fork, and causing the pulley to be immediately gripped and started without delay. Where there is much belt shipping to do, as on mules, planers, etc., there is claimed an increased output of about 5 per cent. and a saving in wear of belts.

The Russian Railway in Manchuria, says Le Génie Civil, is thus referred to in an imperial ordinance, dated at St. Petersburg on December 23: This ordinance approves of the plans of the East Chinese Railway Company for the construction and operation of a railway on Chinese territory, extending from the west frontier of the province of He-Lung Kiang to the east frontier of the province of Kirin, and for the connection of this line with the Transsiberian Railway. To carry out this work the East Chinese Railway Company has been organized under the control of the Russian-Chinese Bank. By the terms of the agreement between Russia and China, the life of the concession is fixed at 80 years, and the stockholders of the company must be Russian or Chinese subjects. The company must commence work before August 16, 1897, and they must finish the railway construction within six years.

The turtle back revolving turrets, recommended by Congressman I. F. Fischer for Romer Shoals, at the entrance to New York Harbor, are thus generally described in a memorial presented by Mr. Fischer: The Romer Shoals lie one mile east of Sandy Hook Point and are four miles from Coney Island, the next nearest land. There are here 35 acres within the 6 ft. curve of soundings, and the space required for three turrets would not exceed 1,000 × 300 ft., easily filled up by sand pumped inside bulkheads. It is proposed that each turret be protected by an oval chilled iron cover of great strength, revolving with the two guns contained within it. With armor of the Gruson type the cost would be small as compared with that of a double turreted monitor. Each turret would require a crew of but 20 men to operate it, and would practically cost nothing for repairs and maintenance in times of peace. As it would project but few feet above water, it would be very difficult to hit, and it would be unassailable by torpedoes. Military authorities, however, say that the cost of foundations will be great, and the question of position and range must be carefully considered before definite action is taken.

ELECTRICAL NOTES.

The electric railway in Cairo, Egypt, is about twenty miles long. More than six hundred miles of American iron and copper wire has been used for this railway.—Uhland's Wochenschrift.

A cable railway operated by electrical power will be constructed in Budapest, Hungary. There will be a tunnel of 492 ft. in length under one of the existing railway stations.—Uhland's Wochenschrift.

Only three countries in Europe have no electric railway, viz., Denmark, Bulgaria, and Greece. Of 111 roads, 91 employ overhead conductors, 12 underground conductors, and 8 storage batteries.—Uhland's Wochenschrift.

According to the London Electrician, there are transforming devices connected to the central stations of Great Britain and Ireland equivalent in capacity to over three million lamps of eight candle power each. Of this, 1,462,000 lamps' capacity is in London and 1,602,000 in the provinces.

According to L'Electricien, in the first six months of the past year the Austro-Hungarian empire imported 148 dynamos and exported 117. Of the imported machines, 104 came from Germany, 31 from Switzerland, and 9 from England. Of the exported machines, 30 went to England, 24 went to Russia, and 14 each to Italy and Germany.

A submarine telegraph cable, 1112·4 knots in length, between Bochum (Germany) and Vigo (Spain), where it joins the Eastern Telegraph Company's system, was opened for traffic on December 25. The undertaking has been financed by a Cologne syndicate known as Deutsche See-Telegraphen Gesellschaft, and is due to the initiative of the German postal authorities.

Recent researches by Prof. J. A. Hennig indicate that pure metals have their electrical conductivity immensely increased by intense cold, while alloys experience in the same circumstances a comparatively small increase, not more than 10 per cent. Prof. Hennig lays great stress on the value of these facts as a means of testing the purity of a metal, almost rivaling the spectroscope in delicacy.

Surveys are being made for the line of a proposed twenty-eight mile electric railroad, which is to connect Norway with North Waterford, Stoneham, Harrison and Bridgeton, Me., says the Electrical Engineer. The road is to be used mainly for freight, and standard steam railway cars equipped with electric motors are to be used. For the passenger service, cars with express, smoking and baggage compartments are proposed.

There are more than 1,300 submarine cables in existence, the aggregate length of which cannot be less than 162,000 nautical miles; they vary in length from a quarter of a mile to say 2,600 nautical miles, and may be roughly classified as follows: Cables under 5 miles in length, 761; exceeding 5 miles and under 50, 223; exceeding 50 miles and under 100, 65; exceeding 100 miles and under 500, 155; exceeding 500 miles and under 1,000, 64; exceeding 1,000 miles and under 2,000, 29; exceeding 2,000 miles, 8.

Anchor ice recently caused trouble in the great power plant at Niagara Falls, according to press reports, necessitating shutting down several of the industrial plants operated by the current. It was stated that the ice formation at the vertical racks, located at the intake from the main canal to the penstocks, had so choked the passageway that only a small part of the usual flow could be obtained. We believe a somewhat similar trouble was experienced a year ago and that relief was obtained at that time by running up a locomotive on an adjoining track and using steam to free the racks.

According to L'Electricien (Paris), D. Kildischevski, a Russian scientist, has invented a new form of telephone of remarkable superiority. It is not necessary to place the ear near the receiver; the voice issues from a metallic funnel and may be heard at some distance by several persons. Very little of its intensity is lost in transmission. In experiments that have been carried on between Moscow and Bostof, on the Don, notwithstanding the 1,342 versts (870 miles) that separate these two cities, the transmission of speech, songs, and music was irreproachable. A large number of officers and functionaries were present at these experiments, and the official report was full of praise for the inventor.

In a recent communication to the London Electrical Engineer, Mr. G. L. Addenbrooke states that unless an entirely new lamp makes its appearance, the voltage of about 250 will be the limit for some time to come. With nearly 500 volts between on a three-wire system, the limit of safety is, under present conditions, about reached. The extra precautions necessitated by going above 500 volts would go a good way toward discounting any further saving in the mains. Although no one would think of operating a lighting and railway system on the same generator, yet the use of 220 volt lamps will permit of using the same generators for both purposes, being connected to whichever service they were needed upon. He states that in many cases marked economy would be secured in this way if accumulators were used to a considerable extent in the lighting.

A report of the working of the Cologne central station for the year ending March 31, 1896, is published in the Elektrotechnischer Anzeiger. The cost of production is stated to be as low as 1·44d. per kilowatt hour—not including interest and sinking fund. The total capital invested in the station amounts at present to £112,700, of which £25,700 has already been written off —including £9,100 during the past year—leaving a book value of £87,000. The total consumption during the year is divided chiefly as follows: Private lighting, 81·18 per cent.; private motors 6·99 per cent.; public lighting, 7·43 per cent. Each lamp installed burnt on an average 463 hours during the year, the maximum demand being during the month of December. The total number of glow lamps connected to the network was, on March 31, 1896, 26,263 50-watt lamps, or their equivalent. In addition to this there were 454 arc lamps and 150 horse power, represented by thirty-five motors. This brings the total lamp and motor connection to 1,701,410 watts, or an equivalent to 34,028 50-watt lamps.

MISCELLANEOUS NOTES.

It is said that a French chemist has made a blue soap which will render unnecessary the bluing in the laundry. In ordinary soap he incorporates a solution of anilin green in strong acetic acid. The alkali of the soap converts the green into blue. No details of the process of manufacture or the formula are given.

The Russians are very fond of all kinds of winter sports. Skating is, perhaps, the favorite, and in the parks the ice soon becomes roughened by the runners of the skates. A large roller is brought onto the ice; this roller is heated enough to melt the surface of the ice sufficiently to make it smooth. This roller is pushed or pulled over the ice by three men.

It having been found that the bullet of the small bore rifle now used by the English army drilled a hole in the advancing assailant so minute and so clean that it failed to stop him in his rush, and even left him ignorant for a time that he had been wounded at all, the military authorities have now decided to adopt a new projectile, invented by a Capt. Clay, which, by spreading and bursting the nickel shell, effects a terrible destruction of the bone and tissue perforated. Of course, this sounds barbarous, and is calculated to add to the horrors of war. But it must be borne in mind that the functions of rifle bullets in war are not to give satisfaction, but, on the contrary, the greatest possible dissatisfaction, to the enemy advancing upon the line.

The Philadelphia Textile School is rightly so great a source of pride to the manufacturing community that the efforts now being successfully made to establish a similar institution in Lowell, Mass., are of much interest here. It is said that the arrangements for opening the New England school are so well advanced that everything will be in readiness in February, when the first term will begin. The prospectus of the school states that the admission examinations will be of a kind that any good grammar school pupil may pass them without difficulty. Intending students must be at least 14 years of age, while the cost to day students, while not yet definitely fixed, is likely to be about $50 per term. For evening students a charge will be made of from 50 cents to $5 a term, according to the number of branches studied, and just enough to cover the cost of materials used. Already applications for admission have been received from many different parts of the State and a good attendance is promised. The school will be under the direction of Christopher P. Brooks.

An interesting experiment in the direction of arresting the ripening of fruit by the refrigerating process has just been concluded by the Technical Education Committee of the Kent County Council. For the purposes of the experiment two small chambers were constructed, each being fitted with a "brine wall"—a flat tank, fitted close to the side of the chamber, and containing brine cooled by the refrigerating machine. On August 26 quantities of apples, pears, plums, French beans, and tomatoes were placed in the "cold store," in which the temperature was at once brought down to between 38° and 40° Fahr. The fruit, etc., was examined at intervals of about three weeks, and it was found that the plums and vegetables did not keep well. On the other hand, the experiment proved successful in the case of the apples, the ripening of which was arrested for at least a month. It is believed that the cold storage system will prove of considerable benefit to fruit growers if carried out on a large scale, inasmuch as it will enable them to keep back their produce from market in times of glut. The refrigerating system has been employed for several years by horticulturists and florists for retarding the blooming time of plants—notably lily of the valley.

The German Trades Commission has published statistics regarding the strikes in 1895, which show that among the bakers, bookbinders, gardeners, glaziers, dock laborers, joiners, carpenters, blacksmiths, tailors, cigar twisters, no strikes worth mentioning have taken place. On the whole, 204 strikes have been reported in 1895, against 131 in the previous year, 14,032 persons joining in the strikes, against 7,328 in 1894. The strikes lasted 1,030 weeks, against 879 weeks in the year before, consuming M. 424,231 from the supporting funds, against M. 354,297 in the previous year. There have been two sorts of strikes, offensive and defensive, the former being those where the men have demanded higher wages and less work, while defensive strikes are those where masters wanted to reduce the wages and prolong the hours for work. The final results of 100 offensive strikes were as follows: In 57 cases the men got the victory, in 18 cases they had only a partial success, and in 25 instances they were defeated. As regards the defensive strikes, out of the 94 cases that were taken into consideration, the men have in 30 cases got the better of their employers, in 12 instances they had but a partial triumph, and in 50 cases they were beaten.

One might be accused of romancing were he to assert that a gun is of several million horse power, and yet nothing is more exact, says the Engineering and Mining Journal. The 100 ton gun, with a 550 pound charge of powder, throws a projectile weighing 2,020 pounds at an initial velocity of 1,715 ft. per second. It communicates to it, therefore, a live power or kinetic force of 92,597,000 foot pounds. The thrust exerted by the gases due to the ignition of the powder lasts less than a hundredth of a second. The result is that during the active period of the work of the powder in the gun the mean power is greater than 87,000,000 foot pounds per hundredth of a second, say 8,700,000,000 foot pounds per second. This represents a power of 12,000,000 kilowatts, or 17,000,000 horse power. There is, unfortunately, another side to this picture. Although large guns are extraordinarily powerful, their active life is essentially ephemeral, since, after 100 shots, they are generally out of service. They have then worked actively one second! The same calculation applied to modern guns that throw 2,200 pound projectiles, and communicate thereto an initial velocity of 1,970 ft. a second, demonstrates, further, that such guns, during less than a hundredth of a second each time, develop a formidable power of 13,050,000,000 foot pounds per second, say 24,000,000 horse power.

THE METEORA MONASTERIES IN THESSALY.

With Illustrations by HERMAN HIRSCH.

THE Meteora monasteries in the northern part of Greece present one of the most remarkable sights in the world, because of their strange location and the peculiarities of the landscape. They lie in a northwestern corner of Thessaly where the river Peneus issues from the Pindus Mountains before passing through the broad, fruitful plain. Just where the valley spreads out to a width of several miles, a group of strange rocks rise like watch towers put there to guard the gate that leads from Thessaly to Upper Macedonia and Epirus. These high, dark rocks attract the eye from a distance, but the nearer one approaches the more wonderful they seem.

An area nearly two miles long and more than a mile wide in its broadest part was covered in the tertiary period by a mass of material washed there by a mountain stream that emptied into the sea. In the course of time this mass was changed to hard nagelflue stone, and what was once the bottom of the sea is now a plateau 1,600 feet to 1,900 feet above the level of the sea, through which the Peneus cut its deep valley, making strange shapes of the originally uniform mass of rock, stranger even than those cut in the rocks of Saxony by the Elbe and its tributaries. The narrow channels washed out by the water have left high isolated rocks with perpendicular or overhanging walls rising to a height of 800 feet above the level of the valley. Here are massive bastions with broad platforms on the top, and there slender towers and pillars or airy needles. At each step the wanderer comes upon new forms that seem to have sprung from the bold fancy of a Doré. Now and then he catches a glimpse of the green valley with its tilled fields and groves, the broad bed of the Peneus and the peaks of the Pindus Mountains, which during the greater part of the year are covered with snow.

Suddenly the deep stillness is broken by the sound of a bell, reminding the traveler that there are human habitations in this apparent wilderness; but in what strange places! High up on the platforms of the separate towers of rock stand stately buildings with balconies and colonnades and in their midst a little church and churchyard. These are the celebrated Meteora monasteries, each one of them being built on the summit of a separate inaccessible rock. It seems impossible to reach these eagle nests, but a strong rope to which a net is fastened hangs through a hole and over the wall of rock, and to this the tourist must trust himself if he wishes to gain the breezy heights. When he has settled himself in the net, the monks above start a windlass to which the rope is fastened, and after a dizzy voyage of a few minutes he is drawn into the hole by means of a hook. Besides this way through the air, most of the monasteries can be reached by ladders placed against the rock, an approach which might be easily interrupted at night or in troublous times by the removal of a ladder. The climbing of these ladders on the perpendicular rocks is so difficult and dangerous for those unaccustomed to such feats that everyone prefers the other way. The first men who climbed to the summit of the rocks attained them only after long and hard work, securing one ladder above the other.

Aside from the beautiful view, there is little to see up there. The monks are hospitable but uneducated; the expensive libraries are scattered or have gone to ruin in inaccessible corners, and, except for some Byzantine sacred pictures, one must not expect to find any works of art of either an architectural or a decorative nature.

No traces of the early settlers have been left on the rocks, nor are they mentioned in history, and consequently we know nothing accurate in regard to the first settling of the monks in this wilderness; but we know that in the middle ages individual hermits made for themselves poor habitations, opening into the caves and niches of the rocky walls, great numbers of which can still be seen. They are all in a more or less advanced stage of dilapidation and are occupied by wild doves and other birds. Many of them are from 190 to 260 feet above the foot of the perpendicular wall, which rises 300 feet more above them. They are little wooden structures that seem to be stuck on the rock like birds' nests, many hanging free over the abyss, supported only by bracketlike beams. It must have cost unspeakable trouble to reach these places by means of ladders and build the little houses there, for they were equally unapproachable from above and below. But in those wild times, when deeds of violence were so common and neither right nor law ruled in the land, which was occupied in turn by miniature kingdoms of the French, Greek and other dynasties that vanished as quickly as they came, when it seemed as if the land was thrown from hand to hand like a ball, many felt a strong desire for peace and quiet as well as an abhorrence of the endless crime which was then ruining Greece; so they and others who were not strong or were persecuted and sought protection from their enemies, retired to a solitary life in these huts.

The Meteora monasteries were founded by a pious monk, Nilos, and their number soon reached twenty-four; most of them, however, were abandoned as early as the sixteenth century, after the Turks had restored

THE METEORA ROCKS AND VILLAGE OF KOSKAKI.

THE MONASTERY OF HAGIA TRIAS IN THESSALY.

comparative peace in the land. The monasteries, which possessed considerable property, formed a co-operative free state whose rights were respected by the Turks. These, like all Greek monasteries, are now under the supervision of the state department, which has the care of ecclesiastical and educational matters. Only five of the monasteries are now occupied (Meteora, Varlaam, Hagia Moni, Hagia Trias, Hagios Stephanos), by about fifty monks.

The Meteora monasteries are visited by nearly all who travel in Thessaly, in spite of their strange location. The railroad takes them from the port of Volos to the little city of Kalabaka in about six hours, and the latter place lies directly at the foot of the Meteora rocks. From there the monastery of Hagios Stephanos

APPROACH TO THE METEORA MONASTERY, HAGIA TRIAS.

is generally visited, because it is the only one that can be reached by ordinary roads, but as the neighborhood of Kalabaka is very unsafe, it is well for the traveler to be escorted by a gendarme.

The monastery of Hagia Trias (Holy Trinity), shown in our illustration, is very picturesquely situated; some of the other cloisters stand on broader rocks, the tops of which serve as pasture, although the cattle can, of course, be taken up and down only by means of ropes.—Ueber Land und Meer.

The number of locomotives built in the United States in 1896 was 1,175, as against 1,101 in the previous year. The increase in the number built for export is very marked, it having grown from 11 per cent. in 1894 to 26 per cent. in the year just closed.

TRANSATLANTIC PASSENGERS.

THE stringency of the regulations as to immigration into the United States is once more reflected in the return of passengers debarked from Atlantic liners at the port of New York during the past year, for while a few years ago, say in 1892, 500,000 were landed, last year the total was 351,573, the decrease being most marked in steerage passengers. Fortunately, many of the old emigrant steamers have been withdrawn—thus 71 tramps crossed in 1893 and only 30 in 1896—so that, instead of about 1,000 voyages being made by all ships, only 852 are included in last year's return; thus the average number of passengers per steamer is 412. This is 36 less than in the previous year, but even then it might be regarded satisfactory if a reasonable fare could be got. In the beginning of last year rates were very low, 30s. to 60s. being taken for steerage; but an agreement as to Continental steerage rates was first arranged, and one effect was a material decrease in the number of Scandinavians traveling by way of Hull and the Mersey to the States. Thus the White Star Line have taken 30 per cent. less steerage passengers, although the total only shows a decrease of 3 per cent. Following upon this agreement, all the companies managed to combine and arranged not only that summer rates should be charged from May to October, but that the minimum cabin rate should be £20 for fast steamers and £15 for steamers of the Britannic and Germanic type and £12 for the City of Rome, while the Allan Line, Dominion Line, etc., are to charge 10 guineas. Formerly the summer was of varying shortness—August to October in several cases—and rates were down to £12 and £15. The winter rates are £15 for the fast steamers and £12 for the Britannic and Germanic type. There is to be no reduction for return fares, and tickets are only to include the voyage from port to port, not the railway fare from London to Southampton or Liverpool. All European companies are included, even although they do not call at a British port, the French charging £17 10s. from Paris to New York with La Touraine and £16 for the other steamers, and the Netherlands-America from Rotterdam £11 10s. With those fares, which came into operation at the end of November, and £6 to £7 for steerage passengers, which have ruled for some months, the Atlantic steamship companies have been doing better lately, and will probably be satisfied should last year's volume of traffic be maintained throughout this year.

The number of cabin passengers last year was 99,223, whereas in the previous year it was 96,558, and in 1894, 92,561. There seems, therefore, an improvement of about 8 per cent. from the lowest point, but, as we have hinted, four and five years ago the normal total was over 120,000 cabin passengers. However, the reduction per steamer has not been so very marked. The average in 1893 was 125; in 1894 it had dropped to 105; by reason of the fewer steamers engaged it increased in 1895 to 122, decreasing again to 116 last year. These figures, however, are somewhat illusory, for many of the ships do not carry saloon passengers. One ought rather to take the total. Thus in the four years named the average totals have been 503, 319, 448, 412. This decrease is due to the number of steerage passengers. During the past year 252,350 voyagers so crossed, probably to seek a new sphere of industry and a new home, for we understand the higher rate obtaining has slightly checked the practice of Italians and Jews returning for a brief season to work in Europe at the busiest time of the year, going back afterward to the States. This partly accounts for the heavy decrease on the figures of five years ago, but much of it is due to the very proper sifting at New York of the useful from the unfit, indolent or improvident immigrants. In 1893 there were 364,700 steerage passengers; cholera and restriction brought the number down to 188,164 in 1894; in the following year there was a recovery to 258,560; the total for the past year—252,350—being thus 6,210 less than in 1895. The total is, therefore, 33 per cent. less than in 1892, while the decrease in cabin passengers is only 18 per cent., and it seems probable that many who formerly went in the steerage prefer the second cabin now.

The fast and new steamers seem to be favored more, alike by the cabin and steerage voyager, for one can trace the influence in the figures. Thus White Star and Inman gained the advantage from their ships in the early 90's, but had to give place to the new Cunarders. The American Line, however, have improved steadily year by year, this year's addition being almost exceptional. As in many previous years, our pioneer company, the Cunard Line, heads the list. Their number of saloon passengers, however, shows a slight decrease of 845, about 4½ per cent., the total being 17,999, while at the same time they carried 20,681 in the steerage, which is not much below the average of recent years. They have also the highest total as an average per ship, which is not surprising, in view of the success of the Lucania and Campania, and of the great regularity of the Etruria and Umbria, which have been making from 19½ to 20 knots on their best voyages last year, notwithstanding that they have been steaming since 1884. The American company take second place again, and their total shows an increase of 713 cabin passengers, or nearly 4¼ per cent., while, when compared with the total for the last year they sailed out of Liverpool (1892), there is an increase of 2,790 cabin passengers. The total is 16,859 cabin and 12,830 steerage passengers. The latter is 6,750 less than in the previous year. The Hamburg-American step from fifth to third place, with a total of 12,173 cabin and 32,280 steerage passengers; but they ran 100 instead of 57 steamers, as in the case of the Cunard Company. The difference, however, was largely due to steerage ships. The number of cabin passengers is 1,630 more than in the previous year, due partly to the practice adopted last year of calling at a French port. Even when compared with 1893, the total is fairly satisfactory, the decrease being only 6¾ per cent., equal to 880 cabin passengers. The decrease on the number of steerage passengers is small. The White Star, on the other hand, have a slight decrease—1·7 per cent.—on the cabin passengers when a comparison is made with 1895; but the number is 1,700 less than in 1893, while the steerage total is 7,656 less than in 1893. The North German Lloyd seem to have experienced the worst decline on the figures of 1893, but this will doubtless be rectified when they get their two new 22 knot steamers from the Vulcan and Schichau establishments. The Anchor Line, whose vessels sail out of Glasgow, have improved on last year's total of cabin passengers, but, like most companies, experience a decline as compared with 1893; while the Allan-State Line have a decreased total, both when compared with last year and with 1893. The French and Red Star Company have not improved on the previous year's total; but the Netherlands Company has done rather better. The totals are given in the annexed table:

PASSENGERS LANDED AT NEW YORK.

Line.	1896.		1895.		1896.	
	Cabin.	Steerage.	Cabin.	Steerage.	Cabin.	Steerage.
Cunard	18,402	25,103	18,844	21,724	17,999	20,681
American	14,374	12,100	16,146	19,580	16,859	12,830
Hamburg-American	13,052	33,091	10,543	30,141	12,173	32,280
White Star	13,327	28,876	11,805	36,725	11,627	21,220
North German Lloyd	15,900	68,465	10,805	44,296	10,921	38,034
Anchor (Glasgow)	8,510	11,546	6,604	10,011	6,940	6,448
French (Havre)	10,205	16,529	7,587	18,469	6,847	17,371
Red Star (Antwerp)	7,015	24,483	4,800	12,554	4,750	13,517
Netherlands	6,295	20,514	3,146	13,702	4,350	13,609
North German Lloyd (Med.)	2,372	17,663	2,065	11,691	2,634	16,146
Allan-State (Glasgow)	3,459	10,298	2,569	3,512	2,390	1,464

It is interesting to note further that the Cunard ships on an average carried 315 cabin and 363 steerage passengers each trip. In the previous two years their cabin

averages were 353 and 336. The American Line took 296 cabin and 225 steerage passengers, as against 323 and 392 respectively in 1895 and 283 and 331 in 1894. The White Star Line carried 632 in each ship, of which 408 were in the steerage; but in the previous year the average was 804. The French Company took 131 saloon and 315 steerage. In these cases it may be taken that there was a regular weekly sailing; while the Cunard and American companies sent five supplementary ships. The North German Lloyd, on the other hand, sent 121 vessels, and the Hamburg-American 100, and as half of these were only emigrant carriers—the two companies stand highest in respect of steerage passengers—it is difficult to approximate the average number of passengers in cabin and steerage in each ship. The North German Lloyd carried 404 per ship and the latter 443, which is far behind the 600 of the two great Liverpool lines.

The only other point of general interest is as to the relative proportion of passengers carried by British ships. Out of 852 voyages, British owned ships made exactly one-fourth—214. They carried 38,845 cabin passengers or 39 per cent., as compared with 40 per cent. of the total in 1895 and 40·5 per cent. in 1893, when the total was satisfactorily high. Our proportion, therefore, has not decreased to any great extent, and at the same time Germany's has remained steady—26·4 per cent. in 1896, 25·4 per cent. in 1895 and 26 per cent. in 1893. They carry a number of cabin passengers, but have a greater steerage traffic. This is not surprising. In 1893 British ships carried 26·5 per cent. of the steerage traffic from all Europe, although very few of our ships sailed from Continental ports; in 1895 we had 30 per cent. and in 1896 27 per cent. German ships took 37·7 per cent. in 1893, 40 per cent. in 1895 and 38·7 per cent. in 1896.—Engineering.

AMERICAN STREET RAILWAYS SEEN THROUGH BRITISH EYES.

WE append the report of a committee sent here by our English cousins to examine our various systems of traction as applied to street railways. The report is interesting and instructive. The English have been conservative, not to say slow, in introducing modern methods of traction, and we believe the comments herewith will be read with interest. The following abstract is taken from the Electrical Engineer, of London.

In accordance with instructions, we have visited America and investigated the various forms of tramway traction. We sailed from Liverpool on September 19, and, after seven weeks' absence, arrived home on November 7. The places we visited in pursuance of our investigation embraced the following: New York, Brooklyn, Jersey City, Staten Island, Philadelphia, Baltimore, Washington, Pittsburg, Cincinnati, Chicago, Detroit, Cleveland, Buffalo, Niagara, Toronto, Montreal and Boston. In all these places we had the pleasure of meeting the leading street railway men. We also saw the mayors of some of the most important cities, and visited the works of the principal manufacturers of street railway equipments. We desire to place on record our high appreciation of and hearty thanks for the courtesy and kindness shown to us by one and all of the many gentlemen in all these connections whom we had the pleasure of meeting in America. They all did their best to make our visit pleasant as well as instructive and useful. We took it as a compliment, not so much to ourselves as to the old country, and specially to the city of Glasgow, on whose behalf we were collecting information. We shall not be redeeming our promises if we do not heartily embrace every opportunity which presents itself of returning the compliment.

In America tramways are universally styled street railways, and the overhead electric system is usually spoken of as the trolley system. It will also be understood in this report that miles of track means single track where double track is not specially mentioned. Operating expenses per car mile are, as a rule, given exclusive of interest and municipal taxes, which usually include all payments in connection with the franchise or the right to construct and operate.

The authors proceed to give details of the equipment in the various towns mentioned above, and then proceed to draw conclusions as follows:

It is about the lifetime of one generation since tramways or street railways became recognized as a necessity of city life. Ten years ago, with the exception of a few cables in San Francisco and Chicago, horse traction was universal. Wonderful changes have taken place since then. Many forms of traction have taken the field, and there has been a fierce and continuous struggle for the supremacy. One outcome of all this has been enormous development. In 1890 (not to go further back) there were 9,037 miles of street railways in the United States; 5,400 miles were operated by horses, 510 miles by cable, 604 miles by steam, and 2,523 miles by electricity. The return for 1896 shows that they have increased to 15,956 miles, of which 1,351 miles were operated by horses, 612 miles by cable, 384 miles by steam, and 13,609 miles by electricity. Within the last five years the number of horses used in operating tramways in America has declined by no less than 80 per cent. Without waiting to trace the history of the traction struggle, we shall endeavor to refer to and discuss the different forms of traction brought under our notice on this visit They have practically all been discussed in former reports already in your hands, but we shall speak of them as seen and judged of in America.

Storage Batteries.—This system was tried some years ago in Washington among other places. After a large amount of money had been expended on experiments, the system was given up as a failure.

Oil and Gas Motors.—Mr. Yerkes, of Chicago, was at great trouble and expense testing the Connelly motors, but they proved unsuccessful, as well as unpopular, and he threw them aside. This is the system which your subcommittee inspected at Croydon. So far as we could learn, there are no other oil or gas motors in America.

The latest compressed air motor which has been brought out—and it has been done with a considerable show of influence—is one patented by Mr. Knight and Mr. Whitney. The former was one of the patentees of the Bentley-Knight conduit system, and the latter is largely interested in street railways. The first of the Knight-Whitney cars was placed on the Lenox Avenue route during our visit, and we had the pleasure of riding on it with Mr. Knight. All we can say is that the car seemed to run all right throughout the double journey (fully five miles) with one charge. But it would be rash to express an opinion regarding the future of anything of this kind in its first experimental stage, although it seemed to us the best compressed air system yet produced.

Electromagnetic Systems.—Closed conduit or magnetic systems have as yet made no headway in America, nor, as far as we could learn, are they looked upon with much favor or hope of practical success. In point of fact, so far as we are aware, no street railway company is at present even experimenting with them.

Electric Open Conduit or Underground Systems.—Electric open conduit installations—modification of Siemens & Halske's Budapest system—have recently been put down, and are being experimented with in Washington and New York. In both cities the overhead system is forbidden. The two experiments are closely allied, and differ only in details. The slot, instead of being in the side rail as in Budapest, is in a third rail in the center of the track similar to the ordinary slot for the cable gripper. In Lenox Avenue, New York, the conductors in the conduit are of channel iron for one portion and 1¼ inch steam tubes for another, while in Washington it is T iron. The cost of construction is spoken of in America as practically prohibitory, and the special work at junctions and crossings is very expensive, one junction in New York having cost £15,000. In Washington the capital outlay for track and equipment is given at about £20,000 per mile of single line, and in New York the track alone is said to have cost that amount; and, of course, the horse track and the asset it represents are wiped out. Last winter there was little frost or snow, so that these underground experiments have not been tested through a severe winter. Both in Washington and New York the cars have been stopped for a short time during heavy rains, but while we saw them in dry weather they were running very well and seemed nicer to ride in than cable cars, and were evidently more popular. One drawback specially spoken of in connection with the operating of the underground system is the great difficulty of locating the defect when anything is wrong. And, of course, apart from snowstorms, there is the difficulty in wet weather of efficient insulation through damp and slush. We observed the electric lighting of the cars working on this system was not quite satisfactory. The lights were dim at times, and went out altogether at the junctions. The streets and climate of Washington are, no doubt, specially favorable for an underground system. Dry weather prevails; the streets are wide, well formed and clean; and on the underground routes there is practically no vehicular traffic heavier than buggies and bicycles. Lenox Avenue, New York, is also specially adapted for the system—long, straight lines, and a clean, wide street, with only light traffic. The company who own this line and have been experimenting with the underground electric system are the same who have now begun to experiment with the latest compressed air motor. Evidently they are not so satisfied with the results of the underground experiments as to justify them in proceeding further in that direction at present. They consider the cost of construction prohibitive, and have recently canceled contracts made in connection with proposed extensions of the electric underground system, just as they had done previously with contracts for cable extension. A short length of the "Love" electric conduit system is still operating in Washington, but a similar experiment has been abandoned in Chicago. As mentioned in our notes under the heading of "Washington," the chief difference between the "Love" and the other underground electric systems is that it has a rolling contact, whereas the others have a sliding contact. Were money no object, and financial results not to be reckoned, an underground electric system can, in a dry climate, be operated where there is sufficient depth (over two feet) to construct a conduit. But it seems very doubtful indeed if, for a city and suburban system, even where that depth can be got, it could be made a commercial success, and all the more so in a damp climate like ours. It is well known that the Central railway construction has made it impracticable to have this system in Argyle Street. On the merits and demerits of the open conduit we have learned nothing which casts the slightest doubt on the thorough soundness of Mr. Arnot's views as expressed in your subcommittee's Continental report. And in any case, with our present knowledge, we could not see our way to recommend the spending of money in entirely throwing away the present tramways and the assets represented by them and constructing an underground system, which is of necessity so expensive to construct, does not admit of general application to all lines of the system, and is only in the experimental stage, both commercially and from the operating point of view, more especially if there is a proved system which is satisfactory and admits of utilizing the present roadbed and is cheaper in every way. We feel bound always to bear in mind that the Glasgow corporation tramways have no rating powers to fall back upon.

Cable System.—The cable system in the earlier days promised to be largely employed in street railways. However, one cannot pass with open eyes and ears through the cities of America without being thoroughly satisfied that it has been superseded. The American street railway men, one and all, speak of it as a "back number." The practical proof of this is that many miles of cable lines have been thrown out in such cities as Philadelphia, Baltimore, Pittsburg, St. Louis, and even in San Francisco, the home of the cable system. We ourselves saw miles of cable conduits being taken up, and the tracks being reconstructed in every case for the electric overhead system. We also saw a few first-rate cable lines in the United States which are not likely to be disturbed in the meantime. The most notable of these are the trunk lines in New York, Chicago and Washington. The New York authorities meantime forbid the overhead trolley system, and cables have, at an enormous cost, been put down in some of the busiest thoroughfares, including Broadway, which has the very busiest street railway in existence. They are all working satisfactorily and successfully, but the management make no secret of their preference for the overhead electric system—if they could get it. In like manner, cable lines are running very successfully in Chicago, in such busy thoroughfares as State Street and Wabash Avenue—ideal cable routes—as also in the main arteries of a few other cities. In all such cases, however, the cables occupy the trunk lines—corresponding to our Argyle and Renfield Streets—and no fair comparison can be made of the operating of such routes and the outside routes which feed them. On the average routes the cable system is more expensive than the overhead electric, and is considered rigid and cumbersome by comparison. There is no probability of the cable system being extended in any of the cities. On the contrary, there is a probability that when the construction or equipment requires renewal this system will give place to the more flexible and popular trolley.

Electric Overhead or Trolley System.—This is now undoubtedly the standard system of tramway traction in America. This is borne out by our notes in the various cities visited, and even more strongly by the actual facts. The invention of a patentee may, on its first appearance, be more or less successfully launched according to the backing it receives from the interest or influence of men of means and position. But no such influence can permanently affect the survival of the fittest. We cannot and need not say anything about the future. But up to the present time there is no difficulty whatever in making up one's mind as to the best surviving and fittest form of street railway traction in America. Street railway managers and engineers have only one answer to the question, From your experience, and taking both efficiency and economy into account, what is the best form of tramway traction for Glasgow to adopt instead of horses? With unanimous voice they answer: The trolley. Each of the patentees and owners of other systems only claims that his system is the best where the trolley is prohibited. And at home we have heard the admission made that the reason why they don't want us to begin with a section of the overhead system is because they are convinced that if we began with it we would have nothing else.

Electricity has undoubtedly played the leading part in developing street railways in America. The trolley system was only introduced some eight or nine years ago, and since then the mileage of the American street railways has been practically doubled, and at the present time no less than 85 per cent. of the total mileage is operated by the trolley, and the percentage is daily increasing. The system had undoubtedly a crude beginning. In a new country all railroads or street railways must of necessity be constructed in the readiest and cheapest way possible. When the district traversed comes to be more settled and populous there is, of course, so much more money and traffic as to admit of a more permanent construction. Horse tramways were, as a rule, in America first laid down in very temporary fashion. Light rails were simply laid on cross ties or sleepers, to which they were spiked, and the ground leveled up or roughly paved, as the case might be. These rails carried the small horse cars in a way, but were totally insufficient to carry the heavier electrical cars at the higher rate of speed. When, therefore, electrical cars were introduced, the whole track had to be thrown out and laid with much heavier rails on a much stronger foundation. In early examples of the electric system the appearance of the overhead construction does not seem to have entered into the minds or calculations of the constructors. This is not to be wondered at. Their chief aim was rapid transit and development. And they were accustomed to seeing the obtrusive wooden telegraph poles on the sides of their streets carrying the telegraph wires, and, later, similar poles carrying the telephone wires in rapidly increasing numbers. The side poles necessary to carry the cross wires for the trolley were insignificant and beautiful by comparison, and so they stuck them up as fast as they could. The people got rapid transit and were delighted. Meantime, in some of the leading cities the appearance of the crude telegraph and telephone poles, and the innumerable wires they now carry, roused the municipal authorities. This was especially the case in New York City—the same city which had sanctioned elevated railways over their streets, which for ugliness have no rival. Whatever they may think of their elevated railroads, they were undoubtedly right in abolishing the huge wooden telegraph and telephone poles, which even yet disfigure most American cities. In many cases State or municipal ordinances have been passed requiring that in five years all telephone wires within certain areas shall be placed in ducts underground. Thus the objectionable poles have disappeared in New York, and are disappearing also in Washington, Boston, Chicago, etc. And no doubt all the chief cities will see it to be to their credit to remove these eyesores. New York has evidently gone off to the other extreme, and will allow no overhead wires whatever. Washington has taken the same position, although the capital has still a good many of the old telegraph poles in her principal avenues. Chicago for a time declined to sanction the trolley system down town, but on the pressure of her own ratepayers the municipality is relenting, and very soon, according to Mayor Swift, the uptown trolleys will run right into the center of the city. The commissioners of the District of Columbia have also forbidden the introduction of the trolley system into Washington. We need scarcely refer to Washington in this connection, however, as it is a place by itself, and has little or nothing in common with a busy commercial city. With these exceptions every city in America has got and is well served by the trolley system, and in no case has the overhead system, when once introduced, ever been abandoned.

After seeing the best overhead construction for the electric overhead system, and considering its vast importance as a means of rapid transit of passengers on city and suburban streets and roads, we are perfectly reconciled to it, and feel that it only wants to be seen in use to be appreciated. Boston seems second to no city in her wish to regard her amenity, and Boston has the trolley everywhere. Mayor Quincy gave us freely his views on the overhead system from his point of view as representing the citizens, and they are in favor of the trolley, which during the last few years has done so much to develop the city. The city of Philadelphia ranks high among American cities. Mayor Warwick, of that city, was quite as frank and strong in his testimony in favor of the trolley, so general and popular in his city. It of course goes without saying that if a system as good and as cheap can be had without any

overhead construction we should prefer it. But there is none such known at present. And we feel sure that if the citizens saw this system of rapid transit in operation on the Springburn route—comfortable cars propelled, illuminated and heated by the same power—they would not for a moment object to the appearance of neat poles to carry the wires, especially if the old lamp posts were done away with, and the trolley poles made use of for electrically lighting the streets. We believe the citizens would soon conclude that it was beautiful as a whole.

Glasgow, as the commercial metropolis of Scotland, must continue to be a city of enterprise and industry. As such let us make it as artistic as we can. Is not the most beautiful ideal of an industrial city, however, one in which all classes of citizens have decent houses to live in as well as plenty of work by which they can earn sufficient money to meet their reasonable wants? These are the necessaries which make it possible for the individual members of an industrial community to live beautiful lives and build up beautiful characters. They must therefore occupy a foremost place in the city which is to be beautiful in the highest sense. Civilization demands that the æsthetic give place in many instances to the useful. We never were pronder of Glasgow than when we heard of the high place assigned to her as a municipality by the Americans. But we have not served twenty years in the health department, and been acquainted with "life in one room," without knowing Glasgow's blemishes—and they are common to all our older cities. One great city improvement scheme has been carried out in our city, and another is now being favorably considered. In Glasgow as it was five years ago there was a population of 565,714 on an area of 6,111 acres, giving 92 persons to the acre, or 58,800 to the square mile. In the present Greater Glasgow, apart from the adjoining but still separate burghs, we have a population of 705,000 on an area of 12,311 acres, giving 57 persons to the acre, or 36,480 to the square mile. When the four separate burghs now served by our tramway system are included, we have a population of 841,000 persons on an area of 14,661 acres, which also gives 57 to the acre, or 36,480 to the square mile. No American city, with the exception of New York, is half so densely populated. No one wishes our citizens to continue so closely packed together as they now are. How are they to be spread out? In our humble opinion, and judging from what we have been privileged to see in America, the most powerful instrument which lies to the hand of the municipality for effecting this purpose is the best and cheapest possible tramway service radiating from the center of the city outward in every direction.

Such a system must be safe, rapid as far as consistent with safety, elastic as to speed, clean, comfortable and attractive, flexible enough to apply to all routes and contingencies of street traffic, and, of course, as cheap as possible; and it would be all the better if each route had its suburban attractions in the shape of a park for music, and the usual facilities for amusement and recreation generally. As surely as you give cheap and rapid transit, which will enable all sorts and conditions of people living at a distance to travel comfortably to and from their work in the city, so surely will houses to accommodate them be built on cheaper ground—meaning cheaper rent—and with healthier surroundings. From all we have seen, we are of opinion that the overhead electric system of tramway traction reasonably fulfills these conditions. Its safety depends upon reasonable care and judgment as to speed and general working. There is practically no danger from the overhead wires, provided ordinary care is exercised in maintaining them properly. No man, so far as we could learn, has been killed by the current from the trolley wires. We have seen dozens of men who have had 500 to 600 volts without injury—in fact, almost every switchboard man has had it, some over and over again. They don't take it because they like it, but they have had it all the same. The president of the West End Company of Boston told us that they had comparatively more accidents with the horse cars than with the electric cars. If this can be said of the system in Boston, there is no reason why it should not apply to Glasgow, for Boston has the overhead system throughout, and down town the traffic is much more congested than in any part of Glasgow. The mayor of Chicago expressed his opinion that the lieges in his city suffered more from bicycles than electric cars. Then the question of electrolysis is one which may freely be dismissed. We were well assured that by working to the Board of Trade regulations there can be no trouble in this connection. Under the rough-and-ready way in which in the early days the trolley system was installed, it is no wonder that electrolysis resulted. The returns were very imperfect. Where the return is sufficient, electrolysis is unknown. Where there have been indications of electrolytic action on gas or water pipes, engineers have had no difficulty in arresting it.

With regard to speed, the electric cars are under perfect control, and can run at any speed. There is no reason why on the average 50 per cent. should not be added to our time table speed for horse traction.

The electric system is eminently flexible. The cars can be backed when necessary (which is not the case with the cable system), and they can easily be turned on to any route. And it is a system which admits of an easy extension of routes in longer or shorter stages as circumstances require. That an electrically propelled car can be made clean, comfortable and attractive by good seating, good lighting and heating if necessary is beyond a doubt, and these are very strong points in favor of electric traction. We believe that the poles, if of neat design and judiciously used for street lighting, can be erected so as not to offend the eye. Where the buildings are continuous, the overhead construction is least noticed. If the cross wires were fixed to the buildings, as in Hamburg, no poles would be necessary at such places, but it might look as well to have side poles throughout. That electric traction is cheap has also been clearly established, and all the more so when all that it fulfills is taken into account. So great and so general have been the changes in operating companies through amalgamation and consolidation that it is now almost impossible in very many cases to get from books or accounts exact figures bearing on the cost of operating by horses prior to the substitution of electric traction.

It may be remarked here that these changes have led in very many cases to over-capitalization, chiefly through watering of stock. In a published table we have seen that in the case of one large company it takes no less than 58 per cent. of the total earnings to pay interest on capital liabilities. The published returns dealing with 15,425 miles of American street railways show that, over all, the capital stock and funded debt amount to £18,293 per mile of single track. In New York State the average is nearly double, being £36,560 per mile of single track. This may explain the reason why a large proportion of the street railway companies in America are not paying dividends. There is no doubt, however, that the companies who have conducted their business throughout on sound financial lines have, as a rule, very good properties at the present time.

Although there was difficulty in getting comparative costs of operating in as many instances as we should have liked, we have given some good and reliable comparisons under the headings of the various cities. In addition to these, a deal of information regarding costs was given to us on the understanding that it was not for publication. These we have taken with the other to arrive at an average. Taking them on the average, the percentage of operating expenses to receipts with overhead electric traction in America is at least 15 per cent. less than with horse traction. The operating expenses per car per mile are, on the average, 3d. less than with horses. There are further financial gains to be taken into account. On the average, as compared with horse traction, the speed of the cars in America is accelerated by over 50 per cent., and the additional traffic developed by the substitution of electric traction has not been less on the average than 25 per cent.

It is true that the development which has taken place in Glasgow since July 1, 1894, may have made it impossible to realize such favorable results here, but we are confident that the results will be all in the same direction, even although the cost of conversion doubled our capital, as in Boston. No doubt it will be borne in mind that an object lesson of 2½ miles cannot be expected to produce as good results as the operation on a large scale of an entire system. It should also be noted in this connection that Glasgow is much better served by city and suburban railways than are the American cities.

The fare which is universal in America is five cents (2½d.) for any distance the car travels, and most companies also give free transfers to other routes in certain directions. A few companies sell discount tickets slightly reducing the five cent fare. The Americans are quite astonished at our one cent fare, and also that their minimum is practically our maximum. There are no cars—cable, electric or horse—in America with top seats like ours, the obvious reasons being the extremes of the climate. Seats on the roof of the car would be too hot in summer and too cold in winter. In most cases close cars are used in winter and open cars in summer. The adoption of the trolley does not interfere with the use of the top seats.

In the matter of organization and management generally we did not consider America in advance of the old country. The cars in America do not carry half as many passengers per car mile as ours do in Glasgow. With regard to the permanent way, there are certainly some points in their track construction which we have very carefully noted, and particularly the rail welding, but, on the whole, there is scarcely a track up to the present time in America equal to what we have recently been putting down in Glasgow, and in very many cases electric cars are running in America on tracks very much inferior to the Glasgow horse tracks. American managers and engineers, while they smile at our still continuing to operate with horses, at the same time congratulate us on our having been able to wait. The pioneers of the electric overhead system have come through a trying and expensive experience. The first motors, generators and equipments were crude, and had soon to be thrown aside in favor of newer designs. These also in their turn became obsolete. Even up till within the last two years great improvements were made, but now it is generally believed that engines and generators, motors and line equipments have all been by experience so much improved that now they are practically standardized, and they can undoubtedly be bought at very much less money than at any former time.

The adoption of large units from 1,000 horse power to 2,000 horse power has very considerably cheapened the cost of production and maintenance in the power station. Electric motors are not only immensely improved, but they now cost only about one-fourth of the price charged in the early days of electric traction, and all the latest electrical equipments are much reduced in price. The result of improved motors and equipments is that the cost of maintenance has been reduced from three cents per car mile to one cent. One of the greatest improvements has been in the controller. The series parallel controller is now almost universally used in America. It not only enables the driver or motorman to regulate the speed to a nicety, but it is also fitted with a reversing arrangement by which he can not only back the car, but can also cause the motors to act as an emergency brake, should occasion arise. By its use there is also a great saving in current as compared with the rheostat formerly used.

Under these circumstances we feel that nothing has hitherto been lost by delay. We also believe that the time has now come when it is perfectly safe to make a move on a small scale, and are satisfied that the opportunities that have been given us for studying the whole question, both in Europe and in America, have brought our information so well up to date that we should have no difficulty in taking in hand to give an object lesson on the Springburn route, of which the citizens will not be ashamed. Although the question of alternating currents for longer distances is at present occupying a good deal of attention, we need not enter upon it here, as direct current would, in any event, be used for a short distance like the route to Springburn. The estimate already given of the cost of equipping the Springburn section on the basis of the present service, apart from any necessary renewal of rails, is £19,575, as detailed in last report by the subcommittee on mechanical traction.

We therefore simply confirm the recommendation of the subcommittee as per their report on mechanical traction in Europe, dated July last, which reads as follows: "That, having carefully considered the whole question, we recommend that the route from Mitchell Street to Springburn be equipped for overhead electric traction as indicated, and that with a view to providing in this way for the necessary augmentation of the service, which is sure to be required next spring, it be remitted to the tramways committee with power to equip this route accordingly as soon as they conveniently can." And we make the further suggestion that the corporation remit to the electric lighting committee, acting in co-operation with the tramways committee, to light electrically as an experiment a portion of the route with a view to utilizing the traction poles for lighting purposes.

CASUALTIES IN MODERN BATTLES.

A PAPER upon "The Effect of the Modern Small Caliber Rifles, and their Bearing on the Military Surgery of Future Wars," read by Major Alfred C. Girard, Surgeon of the U. S. A., before the Salt Lake County, Utah, Medical Society, has been published in pamphlet form. Major Girard recalls the objections made to the Chassepot rifle when it was first introduced, because the injuries inflicted by its comparatively small bore bullet resemble very much the effect of the so-called Express rifles which were prohibited in the Geneva convention. This led to a vast number of experiments and investigation to determine the cause of this peculiar injury. The explanation now generally accepted, says the Army and Navy Journal, is that it is the result of impact at a velocity which is too great to permit the lateral displacements imparted to the circumference of the perforation, and communicates the shock in all directions as far as the continuity of the object extends.

"This effect is a twofold one—hydrostatic when liquid or semi-liquid parts, or a direct transmission in very compact tissues, such as the brittle parts of bones. It does not depend on deformation of the bullet, consequently the jacket of the new projectile and its preservation of shape are no protection. The principal factors are velocity and diameter of the missile. As the old bullet had a greater diameter and the new one a greater velocity, they seem to compensate each other, and the explosive effect of the two projectiles remains the same as to effect, but, unfortunately, is carried still further by the new one."

Experiments have shown that the injuries inflicted by the small bore bullet are not to be explained by the formation of indirect projectiles in the body, such as detached pieces of bone, by the rotation of the bullet, nor by the fusion of the lead and the scattering of the molten particles. Dr. Girard concludes that what we shall have to deal with in future wars are simple perforations in wounds of the soft parts, severe bone injuries as a rule, involving the whole bone, except where the epiphyses are struck, and then only at a range of 600 meters and over. As the modern repeating rifle can deliver forty shots in a minute with fair accuracy, and with a velocity up to 6,000 yards, sufficient to perforate an abdominal cavity, the German estimate of the increase of five per cent. in casualties is a conservative one. Owing to the long range of the bullet, medical officers will be subjected to increased risks, and to keep them out of the firing line "the first dressing stations should be at least 3,000 yards behind it, unless some favorable condition of the ground permitted closer approach. The removal of wounded should not take place until the firing line is removed to a distance of 3,000 yards, or the firing has ceased. In their transport to the first dressing station not only the bearers would be greatly exposed, but the wounded themselves, and it would be better to instruct the men that when hit they would be safer in lying still than in trying to reach the rear. If general instruction was given to the men what to do in case of hemorrhage, the wounded on the line of battle could, during a lull in the fight, be succored by their comrades to prevent death by hemorrhage.

"The first dressing station should, therefore, during the actual fighting, expect to succor only those who by themselves find their way to them and casual cases happening within safe range. No attempt should be made to evacuate the wounded from the battlefield until the close of the fighting, or sufficient advance of the line of battle, then the first dressing station pushed to the closest possible vicinity, the wounded collected, the dressings applied and the most necessary operations performed.

"The collection of the wounded, in order to still more shorten the time of their exposure, would be performed by the reserves, or any troops not engaged in the fight, if there are any, and for this purpose all enlisted men should receive a limited instruction in first aid and litter service, so as to enable them to apply an occlusive bandage, a splint, and properly lift the wounded. Each man, as provided in the German army, should carry some form of first aid packet.

"Unless a particularly safe location can be found for the field hospital, it should be established out of range of field artillery and the extreme range of the modern rifle, or at least 8,000 yards from the firing line. The need of medical assistance on the firing line to arrest hemorrhage is one of the bugbears which modern statistics have laid on the shelf. Out of 87,822 wounds tabulated in Circular No. 6, Surgeon-General's office, of 1865, forty-four gunshot wounds of arteries were registered, or 0·05 per cent. Since from the experiments of the German commission it is shown that injuries of large arteries are rare with the modern rifle, and they of necessity being fatal, especially as the hemorrhage is usually internal and cannot readily be recognized, the hemorrhage calling for treatment will be usually confined to the smaller vessels, which will probably be arrested either spontaneously by the lessened pressure resulting from shock and loss of blood, or by an occlusive bandage."

Mr. J. E. S. Moore, who was sent out to Africa last year by the Royal Society, has discovered in Lake Tanganyika a large electric fish which gives a severe shock on being touched, says the English Electrical Engineer. The electric organs are contained in the skin. Tanganyika appears to be full of queer fish, and, moreover, contains things which ought to be in the sea, instead of in the middle of Africa. Mr. Moore seems also to have the happiness of seeing an entirely new and hitherto undescribed species of crocodile and leopard fight. The Tanganyika may be recommended to fishermen in search of novelty, but not to bathers.

THE NAPHTHA LAUNCH OF THE GAS ENGINE AND POWER COMPANY OF NEW YORK CITY.

No type of a power-propelled boat has acquired such popularity in so short a space of time as has the naphtha launch. The proprietors of the establishment where these boats are manufactured, the Gas Engine and Power Company, of Morris Heights, 185th Street, New York City, term it "the only naphtha launch," and with very good reason, as hitherto it has been without real competitor. While these boats are used extensively in all waters, and have become a most familiar object to all, it is fair to say that very few people know how they are operated.

The engine by which they are driven is a three cylinder, single acting engine specially constructed for naphtha, although it will work perfectly well with steam or compressed air. The engine is surmounted by a double asbestos lined jacket resembling in contour a boiler. Within the jacket is a coil of pipe, immediately below which is a burner for naphtha gas or vapor.

Referring to our illustration of a section of the naphtha launch, a tank for holding the naphtha will be seen in its extreme bow. From the tank a pipe connects with a small pump at the base of the engine, by which naphtha is pumped into the coil of pipe. Into the top of the coil boiler, for such it is, a pipe is tapped that supplies naphtha to the burner. In operation the coil is first made hot. This is done by hand-pumping naphtha vapor mixed with air into the burner, where it is lighted. When the coil is hot, naphtha is pumped into it. This is at once vaporized and develops pressure. The pressure is turned on the engine, which in a few minutes starts to rotate. An injector cock supplies the burner with naphtha, drawing air in also, and the engine thereafter takes care of itself.

At each stroke naphtha is pumped into the coil by the engine. This develops in ordinary practice a pressure of sixty-five pounds in the heated coil. From the top of the coil the naphtha vapor, before it reaches the burner, is drawn off and mixed with air after the fashion of the Bunsen burner. It burns below the coil with a clear blue flame. Near the injector is a damper by which the supply of air is regulated so as to produce this character of flame. After the naphtha vapor has acted upon the pistons and goes off through the exhaust it is condensed. A regular outboard condenser is employed, the pipes running along outside the garboard of the boat. The naphtha thus condensed is forced back into the tank to be used over and over again. The delivery of naphtha from the tank can be cut off by a special valve, shown in a section of the boat, which valve, however, in practice never need be closed.

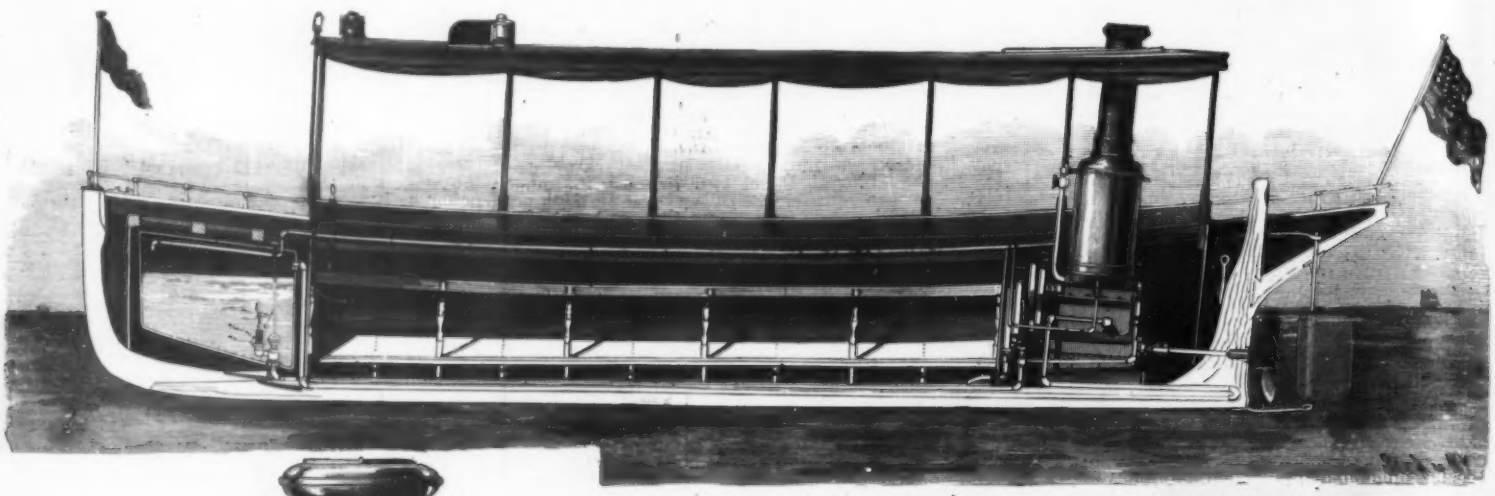
One of our illustrations gives a perspective view of the engine, while another one shows it in section, giving a complete detail view of the construction. The view in elevation shows the general disposition of parts. At A is seen one of the sight holes, by which the character of the flame can be watched so as to be regulated. Through this hole, too, the burner is lighted, and further up in the casing is a second sight hole, through which also the flame can be watched. At C is the injector valve, and immediately below can be seen the flaring mouth with damper, I, by which the air supply to the burner is regulated. D is the naphtha valve through which the naphtha is admitted. B and E are respectively air valve and air pump, which are used only for starting the engine. F is the naphtha pump used for the same purpose. This pump goes out of use once the engine is started, a separate one worked by the engine itself doing the work. The hand wheel, G, starts and reverses the engine according to which way it is turned.

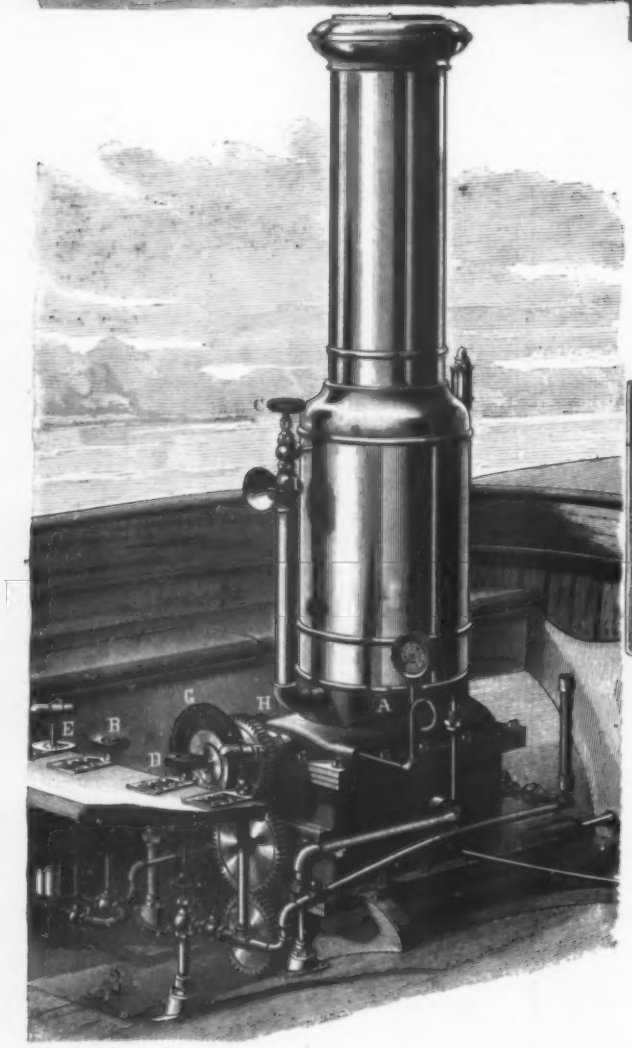
Our view of the section of the engine may be studied more intelligently after inspection of the elevation. The cut shows its three cylinders with the piston rods bearing against hard steel cups beneath the pistons. Each piston is surmounted by its own slide valve, which slide valves are operated by a triple crank shaft. The burner and naphtha coils and the construction of the injector valve, nozzle and air damper are also made clear. Leading out to the right is seen the shaft, whose thrust is taken by a ball bearing, which is seen in section immediately forward of the after sleeve coupling.

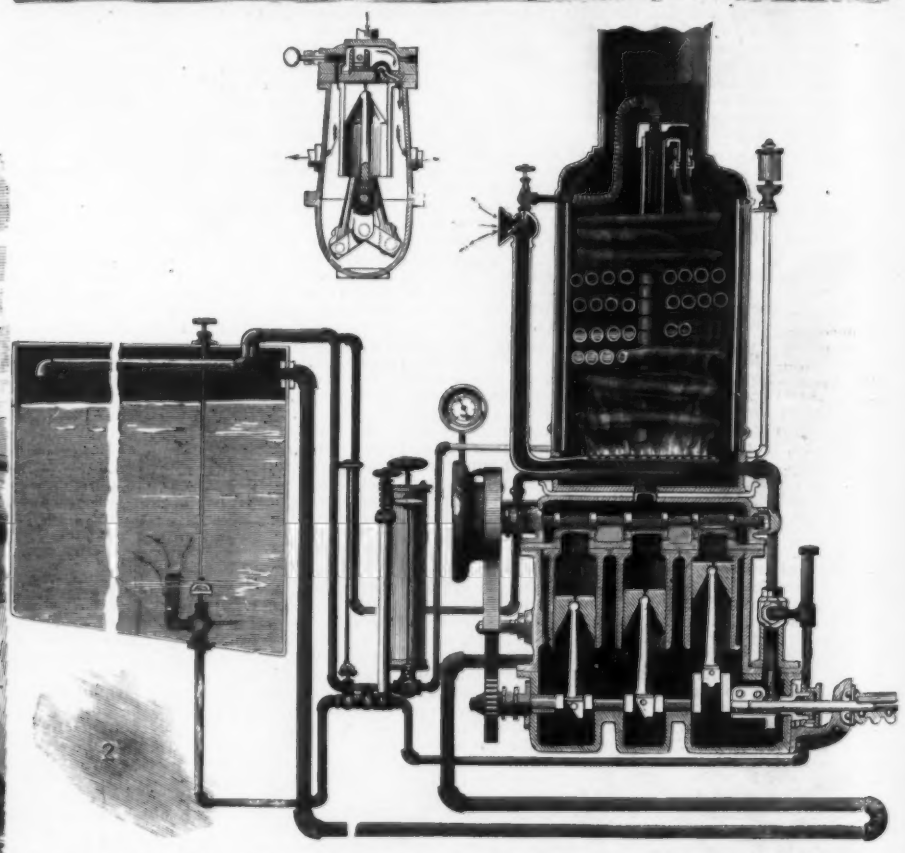
In starting it air is pumped into the naphtha tank, escaping therefrom highly carbureted, so as to provide what is practically a gas for starting the fire. The whistle is blown by a hand pump, or in some of the boats an air tank is established forward, which is kept charged with compressed air by the engine, and the whistle is blown by this air. In our sectional view of the boat the air tank is shown immediately aft of the naphtha tank.

The working parts of the engine are completely incased, so that all leakage of naphtha goes direct to the exhaust chamber. Another point of safety is that the fire is taken direct from the boiler, so that if the feed pump should fail to work, shutting off the naphtha supply to the boiler, the fire would at once go out, and the engine would stop.

These little boats have won for themselves an astonishing record. They seem to be as absolutely secure from accident as any kind of power driven craft can be. Every possible precaution is adopted in their construction to render accident impossible. The boiler is made sometimes of seamless copper tubing, sometimes of heavy iron tubing, with sleeve or threaded joints brazed throughout. The entire engine compartment is bulkheaded off and lined with sheet brass, so that if naphtha burns there it does no harm. The naphtha tank compartment is also bulkheaded off and communicates by sea pipes with the water, so that water is continually going in and out, washing away any trace of naphtha. The entire midship section or waist is unobstructed, and under normal conditions whatever slight amount of heat there may be from the engine is







1. Longitudinal section of launch. 2. Cross section of boiler and engine. 3. Perspective view of the engine.

THE MANUFACTURE OF NAPHTHA LAUNCHES BY THE GAS ENGINE AND POWER COMPANY.

carried aft, away from the passengers. The company's tests have been most exhaustive, but nothing proves the safety of the boats so much as the record which they have made since the foundation of the company.

THE HOLST PUMPING ENGINE.

THE accompanying engravings, for which we are indebted to London Engineer, illustrate a new form of pumping engine, triple or quadruple bucket, with all its pump chambers coupled up into one single continuous line. The motion is derived from a shaft revolving at a constant velocity, and in such a manner that the fluid to be pumped is discharged in one unbroken stream at a uniform speed. The principle of its action is explained by Mr. C. P. Holst, of Amsterdam, as follows:

Suppose an arbitrary number of buckets, all fitted so as to have their valves opening the same way and moving quite independently of each other in one pump barrel, common to all. These buckets move with different velocities and in different directions; some of them may even be considered to be at rest. Then it is obvious that at any given instant only that bucket will be working that for the time being moves faster than all others in the direction of the current, i. e., with the fluid. Only the valves of this bucket will be shut, all other valves being open to let the fluid through. Hence, all the other buckets are quite inoperative, they do not even act as foot or head valves, and their only effect is to offer a certain resistance to the motion of the fluid. From this may be inferred at once that the number of buckets should be as low as possible, and that, as is always the case, the free cross sections should be large and valve seat resistances small.

The bucket thus working alone continues to be in operation until another bucket, of which the speed is increased in the direction of the fluid's motion, has attained an equal velocity to the first. From that moment this second bucket becomes the driving one and will continue to act until in its turn it is surpassed in velocity by a third, and so on. It is evident from the foregoing remarks that, in a multiple pump of the above description, it is quite immaterial to what the full length of stroke of any bucket amounts or what their relative stroke may be. The working length of the stroke for each particular bucket is simply that part of its whole travel in which it moves faster than all other buckets and in the same direction as the fluid.

By the means here explained a continuous flow may be insured, as shown, simply by the co-operation of a certain number of buckets working in one common pump chamber. The velocity, however, would be very variable if the motion were derived from the shaft in the usual way, viz., by a crank and a connecting rod only. For in such a case the maximum velocity is attained only at one particular point, somewhere near the middle of the stroke, as is well known. But the condition that the fluid should always move at the same velocity implies here that the maximum speed of the buckets should be maintained constant over the whole

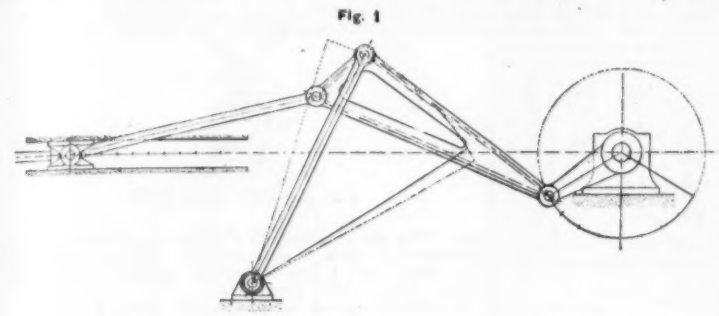


Fig. 1

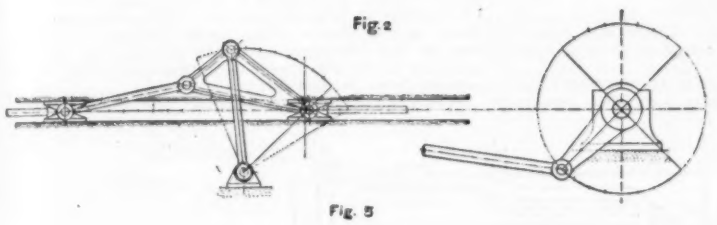


Fig. 2

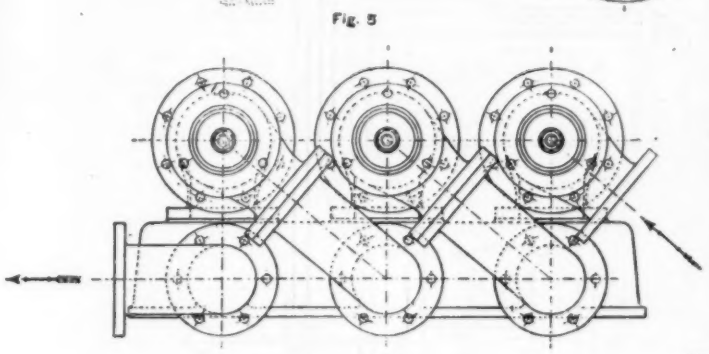


Fig. 5

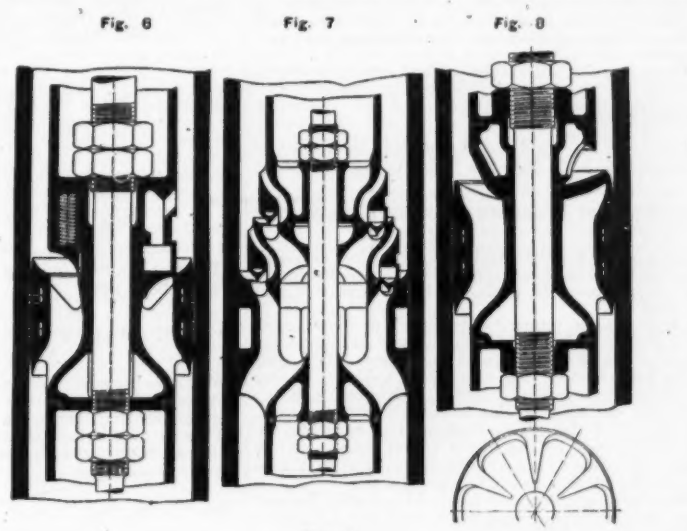


Fig. 6 Fig. 7 Fig. 8

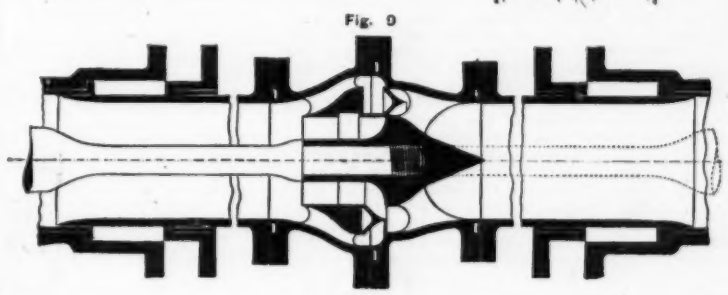


Fig. 9

FIG. 3.

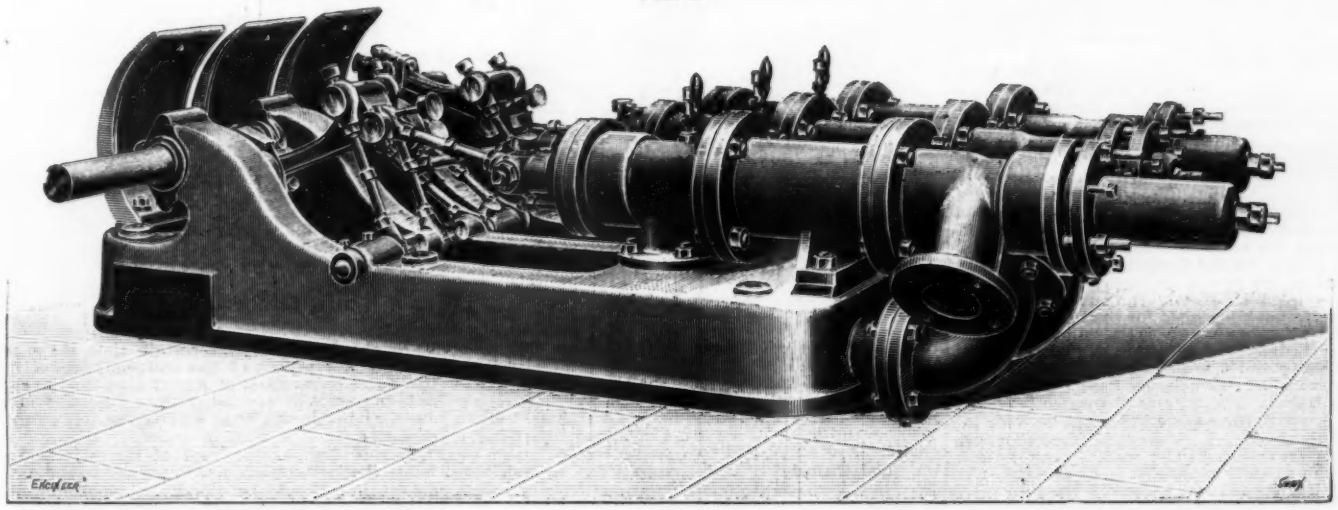
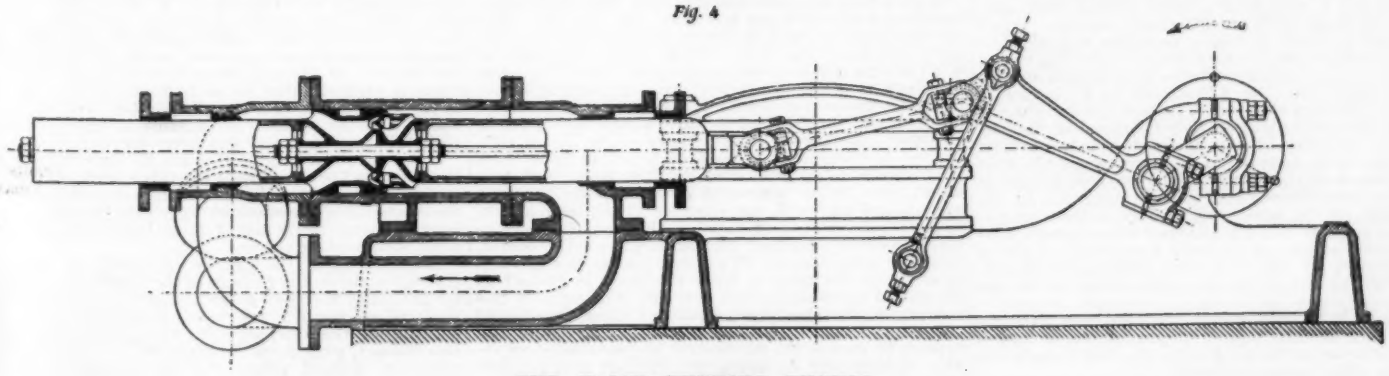


Fig. 4



THE HOLST PUMPING ENGINE.

length of the working part of their stroke. Hence, some new mechanism has to be inserted between the cranks and the pump rods, giving such a motion to the buckets that, beginning from the center, their velocity first gradually increases, then remains constant all through the working part of the stroke, and after the completion of the latter again gradually diminishes to nothing.

From the preceding statements it is clear that, in order to build a pump giving a continuous flow at a constant velocity, and working with n buckets, all driven in the same way, each one by its own crank and intermediate mechanism, it is necessary and sufficient that

(1) These cranks should be placed at an angle of

$$\frac{360}{n} \text{ degrees apart; and}$$

(2) That each intermediate mechanism should be of such dimensions as to keep the pump velocity constant

$$\text{during } \frac{1}{n}\text{-th part of a complete revolution of its crank.}$$

So n is a whole number, to be chosen as low as possible for reasons already referred to, and since it appears that n = 2 is impossible, n should be at least = 3, and at the most = 4.

If a belt driven pump be required, or some other type of pump with its motion derived directly from the shaft, n ought to be 3, and the intermediate gear must be proportional for a uniform velocity during one-third of a revolution. Such a mechanism is shown in Fig. 1, its working stroke being about 75 per cent. of the throw of the crank, making the constant velocity on that part of the whole travel equal to nine-eighths of the mean velocity of a piston that would be driven off the same crank in the usual way.

In this and in similar cases it would not only be useless but even disadvantageous to make n = 4, but the question becomes widely different when a pump is wanted that is to be driven off the tail rods of an ordinary side-by-side two cylinder compound engine with cranks at 90° apart. For now in virtue of the symmetrical position of the crank pin circle relatively to the piston rod, it is possible to use both the outward stroke and the inward stroke of the piston. In fact, if two buckets are placed tandem fashion on one common rod, care being taken to arrange them with their valves opening opposite ways, and this rod be driven by the tail end of the piston rod of the steam engine, the mechanism of Fig. 2 being inserted between them, the motion required for the buckets will be found each half revolution of the crank, and there will always be one bucket in operation, the other one at the same time being idle. In this way an arrangement is arrived at with four pumps, but with only two cranks and two motions, giving exactly the same results that could be obtained from four cranks with four intermediate mechanisms. Hence, the gear shown in Fig. 2 has to be designed for a constant velocity during one-quarter of a revolution only, and then gives a length of working stroke equal to about 71 per cent. of the stroke of the steam piston, making the constant velocity of the pump equal to seven-fifths of the mean speed of the engine's pistons.

In some cases this last property of the link work shown in Fig. 2 might be considered a drawback, since it gives to the water a speed exceeding that of the cylinder pistons by 40 per cent. This consideration gave rise to the design of a third type of intermediate mechanism, by which it is possible to reduce the velocity of the water in any desired proportion to the mean piston velocity of the engine. For other proportions, similar mechanisms can easily be found, the pump rod being always below the piston rod and parallel to it, and the smaller the ratio between the two velocities, the shorter should be the distance between the rods. In all three cases the new gear consists of exactly the same parts, coupled in exactly the same way, so that the same description holds good for the three types.

A complete pumping engine is shown in Fig. 3, and the inventor has described other forms, including that shown in Figs. 4 and 5, which are views of a triple power pump, the link work to be used being that of Fig. 1, as explained. The flow of the water is clearly seen in Fig. 5, where the connecting bends between the pumps are fully shown. The bed plate has under each pump a pipe, cast with it; the water forced through the pump immediately above it flows through this pipe toward the rear end and thence by the bent pipes toward the suction orifice of the next pump.

Fig. 6 shows a section of a small bucket with only one annular valve with outside water passage. Fig. 7 is intended to show the same principle as applied to large and very large buckets, where more ring valves are fitted—two being shown here—with outside and inside flow past them. Fig. 8 illustrates an India rubber flap valve, the plan view showing how the cup-shaped disk is cut into six almost entirely independent flaps to avoid the stiffness of the undivided valve. This bucket has been designed to be interchangeable with that of Fig. 6, so that both might be tested against each other expeditiously and with little expense in the same pump, on the same rod, and even between the very same trunks. For installations where a considerable length of pump can be used, the peculiar form of bucket shown by Fig. 9 is very suitable and recommends itself by the facility of access to the valves and seats.

To show both the valves and the free passages through their seats as clearly as possible, these figures are drawn in halves, one side with the valves open, the other side with the valves closed.

To submit Mr. Holst's statements and the invention to a practical trial, the "Nederlandsche Fabriek van Werktuigen en Spoorwegmaterieel," of Amsterdam, have built an experimental pump for their own water service. Figs. 3, 4 and 5 are engravings of this pump, and to it the two interchangeable buckets, Figs. 6 and 8, belong. The principal dimensions are:

Diameter of crank pin circle	200 mm. = 8 in. nearly.
Length of working stroke	150 mm. = 6 in. nearly.
Free cross section throughout	50 cm². = 7¾ sq. in.
Delivery per revolution	3·25 liters = ⅘ gallon.
Diameter of pump barrel	128 mm. = 5 in. full.
Diameter of pipes	80 mm. = 3⅛ in. full.
Diameter of trunks	100 mm. = 4 in. nearly.

This pump was tested at from 160 to 240 revolutions per minute, and has, we are told, given complete satisfaction. With respect to the action of the valves, the following results are given:

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Bucket after Fig. 6, but without springs on the valves.

Reference No.	Revolutions per min.	Vacuum at suction atmospheres.	Pressure at discharge, atmospheres.	Total head in atmospheres.	Total quantity in liters.	Total number of revolutions.	Efficiency of volume per cent
1	160	0·5	0·9	1·4	1473	660	99·2
2	160	0·6	2·2	2·8	1484	672	98·1
3	160	0·6	3·0	3·6	1481	671	98·1
4	160	0·6	4·75	5·35	1498	680	97·9
5	220	0·6	2·6	3·2	1463	665	97·8
6	240	0·6	2·8	3·4	1471	666	98·2
7	240	0·6	3·0	3·6	1449	652	98·8
8	100	0·5	2·0	2·5	1611	720	99·4

Trials to determine the mechanical efficiency have not yet been held.

APPARATUS FOR LIGHTING WITH ACETYLENE.

WE give herewith a description of three new pieces of apparatus designed both for the production of acetylene and for lighting therewith.

CAMPE'S GAS GENERATOR FOR ACETYLENE LIGHTING.—In lighting with acetylene gas, it is necessary that the flame shall assume its full size at once when the gas is lighted, and that when it is extinguished the production of the acetylene shall immediately cease. To this effect Mr. Robert Campe has devised the apparatus which is represented herewith in Figs. 1 and 2.

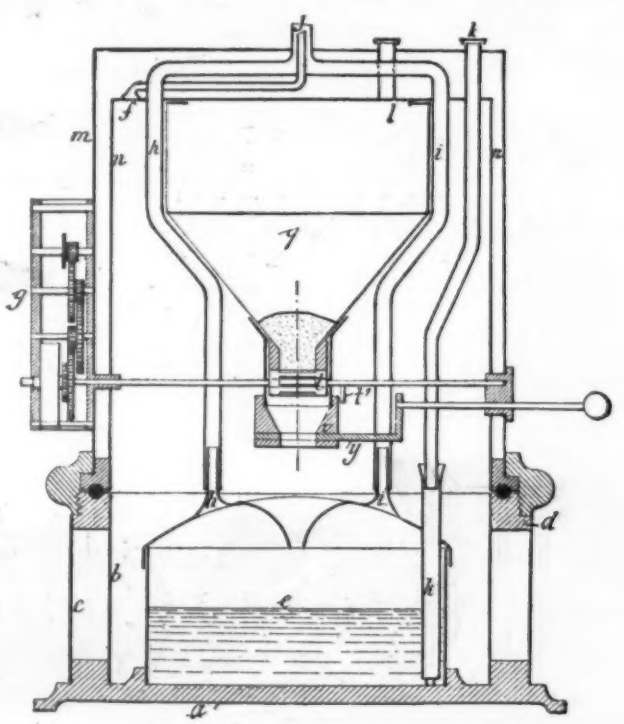

FIG. 1.—CAMPE'S ACETYLENE GAS GENERATOR.

Upon the base, a, are fixed a closed receptacle, e, partly full of water, and two concentric cylinders, b c, provided with a threaded coupling, d, that serves to join them hermetically with two concentric cylinders, m and n.

With a view to preserving the heat disengaged during the formation of the acetylene, the annular space between the upper and lower cylinders, as also the space between the tops of the upper cylinders, is filled with a non-conducting substance, such as ashes or asbestos. From the top of the cylinder, n, is suspended a hopper, q, containing powdered carbide of calcium, and provided at its base, which terminates in a narrow canal, with a distributer. The latter consists of a wheel, t, with buckets, keyed upon a shaft that is revolved by clockwork, g. The buckets of this wheel take up in succession a small quantity of the carbide and empty it, one after the other, into a box, v, provided with a slide valve, y, that may be maneuvered from the exterior. The shaft of the distributer, t, carries a stop tappet, t', which abuts against the vertical side of the valve, y, when the latter is pushed to the end of its travel toward the left, and prevents the rotation of it. This valve is, nevertheless, capable of closing the box, v, without placing itself before the tappet, t', so that the distributer may continue its rotary motion and discharge the carbide that remains in the box.

The opening of the box, and, consequently, the flow of the carbide into a central funnel arranged in the cover of the receptacle, e, is regulated by means of the valve, y. From the cover start two vertical conduits, h and i, which embrace the hopper, traverse the bottom of the internal cylinder, n, and then connect with each other so as to form a single conduit, j, through which the acetylene gas flows directly into the pipe that supplies the burners, or to the burner itself.

A tube, k, prolonged toward the bottom of the receptacle, e, debouches above the apparatus, where it is closed by a screw plug in order to provide the receptacle with water, the level of which must in no case reach the funnel.

As may be seen, the top of the internal cylinder, n, is provided with two conduits, one of which, f, enters the central tube, j, and the other, l, which is very short, debouches externally when its screw plug is removed in order to fill the hopper, g, with powdered carbide of calcium. As soon as this product is emptied into e by the distributer, there occurs a very intense disengagement of acetylene gas, which flows through the conduits, h i j, to the burners under the effect of the pressure resulting from the production of

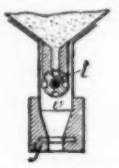

FIG. 2.—DISTRIBUTER.

gas. The gas that escapes through the funnel of this receptacle is likewise sent into the conduit, j, through the small tube, f, any abnormal pressure in the cylinder, b, being thus prevented.

In order to arrest the production of the gas and extinguish the flame, the valve, y, whose bent part is placed before the tappet, t', is closed, and the shaft of the distributer is thus arrested. The extinction of the flame occurs almost immediately through the cessation of the introduction of the carbide; so, too, the pressure in the gasometer disappears, and thus no gas escapes from the burner.

When the operation is resumed, the flame could not be relighted until after a certain time, if the apparatus did not permit of the sudden introduction into the water reservoir, e, of a sufficient quantity of carbide to permit of at once attaining the pressure requisite for lighting the flame and giving it its full development.

To this effect, at the time of the extinction of the lamp, the valve should not be pushed to the end of its travel, but should be placed in an intermediate position that shall cause the closing of the box, v, while not interfering with the tappet, t', of the distributer. The latter consequently continues to revolve under the action of its clockwork mechanism, and to give passage to carbide of calcium, which accumulates in the box, v. At the end of a certain length of time, the valve is pushed home so as to completely arrest the apparatus. Moreover, the distributer would stop of itself under the resistance to friction to which the complete filling of the valve box gives rise.

It will be understood that when the apparatus is set in operation the opening of the valve produces the immediate fall of the charge held in reserve, and an abundant disengagement of acetylene, that permits of lighting immediately and of obtaining a flame of maximum illuminating power.

The intensity of the light is regulated by reducing, through a valve, the passage of the feed box. The latter gradually becomes gorged, and there comes a moment when the friction causes a slowing up of the distributer, the discharge of which, beginning with this instant, puts itself in concordance with the consumption judged proper for the regularity of the lighting.

MARESCHAL'S ACETYLENE GENERATOR.—In an acetylene generator for a portable lamp, the supply of carbide of calcium is generally put in contact with the water. Such supply is arranged in a column so that the contact of the water shall always occur at the base, and cease as soon as the production of the gas is sufficient. As the carbide is hygrometric, it happens that the production of gas continues, because the water of the first layers gradually makes its way upward and increases through the vapor produced by the reaction. So the carbide is finally attacked throughout its entire mass.

Mr. Mareschal has got around this difficulty by gradually feeding, in measure as it is needed, the car

bide in powder or pastilles placed in a reservoir, A (Fig. 3), that surmounts the water vessel, B, and communicates with it through a tube, T. This tube is closed with a cock, R, provided with a capsule and connected with a regulator, D, that acts in such a manner that when the pressure descends below a certain limit, the cock makes one revolution and allows the carbide contained in its capsule to fall into the vessel, B. As the pressure immediately rises, it acts anew upon the regulator, and the latter revolves the cock, which takes in a new supply of carbide.

Above the level of the water in the vessel, B, there is arranged a funnel whose aperture is situated over a

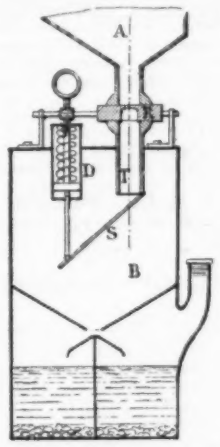

FIG. 3.—MARESCHAL'S ACETYLENE GAS GENERATOR.

central cone. The object of this arrangement is to divide the carbide at its entrance and also to condense the aqueous vapor that forms during the reaction.

The regulator, D, consists of a cylinder provided with a piston that is made to descend through a spiral spring, and that is provided with a rack whose pinion actuates the key of the cock, R. A rubber disk, S, connected by a rod jointed to the piston, follows the motions thereof and closes the tube, T, when the pressure reaches its maximum.

THE MORISON LAMP.—In the lamp of Mr. Hartlepool, the calcium carbide is placed in a perforated conical holder suspended by means of springs, D, the tension of which is regulated by means of screws, E. When there is an excessive production of gas the pressure increases and the level of the water in D is lowered, so that the liquefaction of the calcium carbide takes place over a smaller area. This results in a diminution of the production of acetylene; thus it is seen that the apparatus is automatic and is regulated according to the consumption. The products of the lime pass through the perforations, F, of the holder, G.

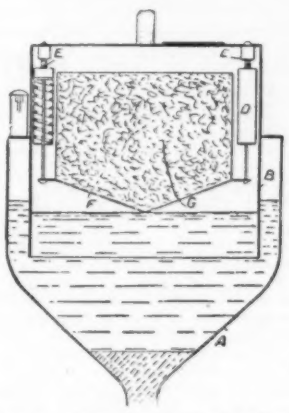

FIG. 4.—THE MORISON LAMP.

into the water contained in the body of the lamp, A, and raise the level of the water, but as the residue is formed the weight of the carbon diminishes and the springs, D, raise the holder. The function of the lamp is thus regulated automatically. A safety valve, L, is placed near the top of the reservoir, A, and its function is rendered automatic by means of a float which is connected with the valve.—Revue Industrielle.

ELECTRIC TRACTION IN THE PARIS SEWERS.

THE main sewers of Paris are periodically cleared by means of scrapers carried on cars or boats. These conveyances are also used for conveying visitors through the large sewers under the Rue de Rivoli and the Boulevards de Sebastopol and des Malesherbes. These expeditions take place fourteen times a year, in spring and autumn, and about 8,400 visitors are admitted yearly, says the Safety Valve. Until 1894, these cars and boats were drawn by men, but the labor and expense were found to be so excessive that now the traction is entirely done by electric motors, taking current from accumulator batteries on the boats or cars.

These main sewers are in section very similar to an ordinary tunnel; but in the floor is formed the rectangular channel for the sewage, while round the roof are fixed the water and compressed air mains, the telegraph and telephone wires, etc.

The sewer under the Boulevard des Malesherbes is the largest; it is 18 ft. 4⅛ in. wide, 10 ft. high from floor to roof, and the sewage channel in the floor is 3 ft. 5¼ in. deep and 9 ft. 10 in. wide. Boats are used in this channel. The other sewers are smaller, the channels in them being only 3 ft. 11 in. wide, and from 3 ft. 11 in. to 5 ft. 7 in. deep. In these, cars are run, the flanged wheels of the cars running on the edges of the channel, which are protected by angle bars and form the rails. The approximate weight of a train of five cars, with 100 passengers on board, is about 7 tons 12 cwt., and this travels at the rate of 3¾ miles per hour. The accumulator battery consists of 28 elements and weighs 14 cwt., and its capacity is 100 ampere hours, with a mean discharge of 25 amperes at 50 or 60 volts. The motor, which is series wound, develops 2 h. p., and runs at 1,600 revolutions per minute, this speed being reduced to 80 by means of a pinion and wheel and chain gearing to the driving axle, the wheels being 15¾ in. in diameter on the tread.

The boats are towed by means of a chain sunk in the sewage channel, which is brought to the surface and passes round a pulley driven by means of a double reduction gear from the motor. The chain, by means of guide pulleys, makes three-quarters of a turn round the driving pulley, this pulley being a magnetic one, magnetized by means of two coils, one on each side of it on the axle. Each passenger train consists of six boats, in the first of which is carried the accumulator battery and a towing apparatus; while in the last boat, which is smaller, there is another towing apparatus. The battery consists of sixty elements, giving an output of 60 amperes for 2½ hours, at from 98 to 125 volts; it is divided into two parts, which can be connected in series or parallel as required. The motors run at 580 revolutions per minute; but this speed is reduced by means of the gearing, so that the boats travel at about 1¼ miles per hour. The power required for this is from about 2 to 5½ h. p., according as the boats are traveling with or against the current.

The total length of sewers open in this way to the public is about two miles, and they are lighted partly by lamps on the footpaths or by oil lamps on the boats.

THE SETTING AND STRAIGHTENING OF GUN BARRELS.

THOSE who have not watched very closely the manufacture of guns will learn, not without some surprise, that the modern exigencies concerning the precision of portable firearms has reacted but slightly upon the processes employed for the last two centuries. There is no doubt that the general verification, of which we shall presently speak, has made sensible progress, but the detailed methods of examination have remained about the same. The straightening of gun barrels has, up to recent years, been confided to a small number of special operatives, who, through particular arrangements, and especially after long practice, have succeeded in indicating quite accurately the interior defects of a gun by a mere inspection of the barrel. The method employed has been what is known in arsenals as the "wax taper process."

The gun whose defects it is desired to ascertain is directed against a screen half white and half black, the distorted image of which is examined in the interior of the barrel. The line that separates the two halves of the screen appears then in a form analogous to that of a wax taper; whence the name of the process.

The drawbacks of this system are obvious. Whatever be the skill of the workman, it is very difficult for him to locate the place of a distortion and its extent and amplitude. Such a defect, entirely local, as would necessitate a simple boring is characterized as a curve, which is produced in an opposite direction in trying an ineffective straightening. Then, again, the workman does not always pay the same attention to and take the same interest in his work. A little negligence will lead to endless retouchings on account of having been badly begun. Against errors of this kind the foreman of a shop is helpless. Although a mechanical process had to lead to the regrettable result of suppressing the artists of this industry, a reform in the work was so much the more necessary in that greater precision was sought for in the manufacture of the weapons. We shall see further along how delicate are the verifications to which the guns are submitted, and, instead of being surprised that a simple inspection by the workman has become insufficient, we shall rather be astonished that so elementary a process has sufficed for so long a time. In French manufactories it has just been replaced by an extremely simple optical method devised and elaborated by Capt. Charles Dévé.

Capt. Dévé's apparatus consists essentially of a mirror that slides along the gun in assuming in succession the inclination of all the places at which it passes, and the motions of which are measured by examining those of the image of a thread that it reflects.

Practically, the apparatus is arranged as follows: The mirror is fixed to the front of a small cylinder that exactly fits the bore of the gun through two swellings. On one side these latter are applied against the grooves, and are pressed at a point diametrically opposite by two flat springs. In its progressive motion the cylinder will, therefore, indicate the defects in the straightness of the gun according to the generatrix opposite the spring. Upon putting the spring successively up, to the right, down, and to the left in four successive observations, we shall have determined the exact form of four lines situated at right angles, going from one end of the gun to the other, and we shall be able, with the greatest ease, to differentiate the general curves from the local defects.

For observing the motions of the mirror, Capt. Dévé adapts to the front of the gun an auto-collimator telescope, that is to say, a telescope focused upon the infinite, and provided at the focus of the objective with a reticule. The threads, illuminated through a lateral aperture and an inclined mirror, Fig. 1, send to the mirror parallel rays that return to form an image in the plane of the reticule. The initial inclination of the mirror is here without consequence, on condition, however, that it be slight enough to allow the image of the reticule to return into the telescope. Whatever be the position of this image, we shall observe only its displacements, which will indicate the variations in the inclination of the mirror.

The practical form of the apparatus is as follows: The cylinder that carries the mirror, M, is connected through two links with a rod controlled by a cord that runs over a pulley, Fig. 2. The object of the links is to allow free play in the transverse direction. The cord may be actuated by its two extremities, so that it is possible it will be able to make the mirror advance or recede. The position of the explorer in the barrel is indicated by a small metal plate, P, mounted upon the cord and provided with two small projections opposite the two inflations of the cylinder.

The reticule is fixed in the telescope and the latter is mounted upon a support that permits it to take on two motions at right angles, which are communicated to it by means of two screws with milled heads.

At the beginning of the operation the telescope is so regulated that the reticule and its image shall be

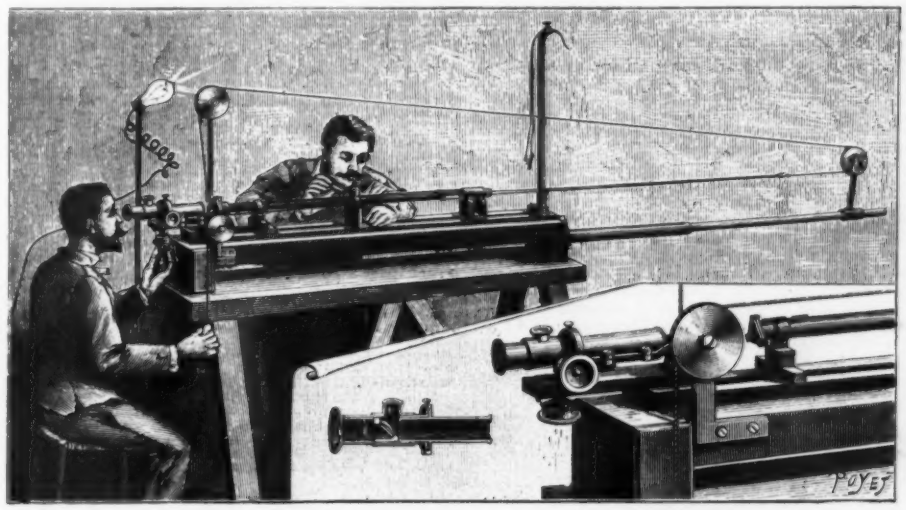

FIG. 1.—DEVE'S APPARATUS FOR EXAMINING GUN BARRELS.

superposed. Afterward, through a comparison with the teeth of the two combs placed in the plane of the reticule, we estimate the motion of the image, or else bring back the coincidence by acting upon the screws. In the apparatus in use at Chatellerault one tooth of the comb corresponds to an angle of 1-1000, and one division of the screw head to an angle of 1-5000. We shall, therefore, be able to very easily estimate a defect in the barrel corresponding to a deviation of one decimeter in 500 meters. The approximation might be carried further if it were judged necessary by increasing the dimensions of the apparatus.

The maneuver of the instrument is exceedingly simple. The barrel of the gun having been fixed in two collars, an assistant introduces the mirror through the breech end up to the edge of the muzzle. The observer then regulates the telescope, and, acting upon the cord, gently draws the mirror toward the breech. Guns of the 86 model are provided with four grooves of

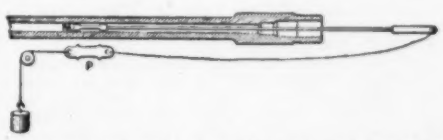

FIG. 2.—DIAGRAM OF THE EXPLORATION OF A GUN BARREL.

constant pitch of 24 cm. The intervening parts are therefore 6 cm. distant upon the same generatrix. The passage of the edge of the groove over the partition is therefore shown by a slight motion of the image to which no attention need be paid. Observation is directed, on the contrary, to the positions of the image under analogous conditions of the placing of the explorer which are renewed every 6 centimeters. The indications of the instrument are very easy to interpret and verify. The observer, seeing the image deviate to the right or left, in one of the four principal directions, indicates to his assistant the existence of a defect, as well as its direction and its extent. The assistant, provided with a piece of chalk, marks upon the barrel the place of the defect and the side of

the gun that it is necessary to strike in order to straighten it.

We have said that the defects of the gun have to be determined for four generatrices situated in two rectangular planes. This is true in principle, and it is effectively thus that we operate for very accurate regulations. But, in practice, the exploring cylinder is sufficiently pressed in all directions to at once indicate all the defects, as long as it is a question of medium precision.

The apparatus is very quickly used. In a day of ten hours, one experienced observer can, with its aid, examine 500 gun barrels. However, for approximate work, the "wax taper" process is still employed, no longer for estimating defects, but for ascertaining their absence. The first result of the optical verifier was to render the straighteners more attentive by revealing their least mistakes.

The application of the apparatus that we have just made known refers to the barrel alone during its manufacture and boring; but, when the weapon is finished, it is well to make a general verification bearing upon the angle formed by the line of sight and the last element of the barrel. To this effect the gun, suspended from a strap passed through the trigger guard, rests through the sight notch and the muzzle sight in two supports firmly fixed to a platform. The telescope, whose position with respect to the straight line joining these two supports is invariable, indicates, through a single observation in the mirror, the angle formed by this straight line and the axis of the barrel in its last section of 6 centimeters. The graduation is so effected that the deviation read in the telescope expresses in centimeters the deflection in the projectile that would take place at 200 meters distance.

The guns judged good are accepted. Those that exhibit defects in regulation scarcely exceeding the limits of tolerance required from the regulator are tried by firing. Finally, guns in which the error is considerable are taken apart and the various elements are tried separately.

The verification as a whole has led to very curious observations upon the influence of slight curves in the vicinity of the muzzle. Guns judged defective and tested by firing have given very different results from those that might have been expected. For example, a gun that ought to have shot 30 cm. to the right, shot straight forward, but 30 cm. too low. If an endeavor be made to regulate the fire by raising the extremity of the barrel, the defect is aggravated. Such deviations of the projectile at right angles with the direction of the error seem odd; and yet, when an endeavor is made to ascertain, through calculation, the stresses resulting from a lateral displacement of the projectile moving with great velocity, we are surprised to see how great such stresses are.

Let us, for example, take the projectile of the gun of the 86 model, whose weight is 15 grammes, and whose initial velocity is 650 meters per second. Let us suppose that the barrel be bent so that an examination of the last 6 centimeters reveals a deviation of 20 centimeters at 200 meters, say 1-1000. At its exit from the gun the ball will have to take, in these 6 centimeters, a transverse motion giving it a direction erroneous by 1-1000. It will have to deviate from a straight line by 0·003 cm., the curve being supposed parabolic and the acceleration constant. The mean transverse velocity will be

$$\frac{0{\cdot}003}{0{\cdot}000{,}092} = 32{\cdot}5 \text{ cm. per second.}$$

The transverse velocity upon its exit from the gun will therefore be 65 cm. per second, and the acceleration will be

$$\frac{0{\cdot}65}{0{\cdot}000{,}92} = 707 \text{ meters per second.}$$

The stress in kilogrammes necessary to deflect the ball will therefore be

$$\frac{707 \times 0{\cdot}015}{9{\cdot}81} = 10{\cdot}8$$

Thus, this slight deflection of the projectile, which, for a travel of 6 centimeters, reaches 3-100 of a millimeter, requires on the part of the gun a stress of 10·8 kilogrammes. It is therefore not surprising that the effects of the fire are very different from those indicated by the purely geometrical examination of the gun. The reaction of the ball ought to produce distortions of the barrel and bring the shot partially in direction. Yet, along with a transverse motion, there rests in the ball a tendency to revolve around a vertical axis. Through gyroscopic action, such tendency is transformed into a revolution around a horizontal axis. The point of the ball lowers, and, through its sliding upon the air, is deflected downward.

The precautions that are taken to perfectly adjust a gun may seem exaggerated when it is a question of an army gun. Capt. Dévé himself answers this criticism that might be made of his method. We cannot, in conclusion, do better than reproduce the justification that he himself gives of his process:

"Officers, who consider before all else the gun in its use upon the battlefield, will perhaps find the search for extreme accuracy in a weapon of war futile; but, although the use of the gun against very wide targets is general, it should not be forgotten that circumstances will occur in which the soldier will have to take advantage of all the precision of his weapon. Scouts and sentinels will often be so situated. Now, is it not sufficient that such a thing may occur to justify the use of means capable of increasing such precision to such a degree as may be deemed necessary?—La Nature.

A paper was recently read before the American Society of Mechanical Engineers by Mr. C. H. Benjamin, on "Friction Horse Power in Factories." The author recommends the observance of the following rules in machine shops: (1) Use pulleys of large diameter on counters and narrow fast-running belts; (2) use nothing but the best oil and plenty of it, catching all drip, and either purifying it or using it for some other purpose; (3) have all the shafting and counters oiled regularly, and do not depend too much on automatic oiling; (4) inspect the line shafts from time to time, and see that they are in line and can be turned easily.

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